DOCUMENT RESUME

ED 270 599 CE 044 545

AUTHOR Crohn, Leslie

TITLE Technological Literacy in the Workplace.
INSTITUTION Northwest Regional Educational Lab., Portland, OR. Education and Work Program.
SPONS AGENCY National Inst. of Education (ED), Washington, DC.
PUB DATE Sep 83
CONTRACT 400-83-0005
NOTE 69p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Educational Needs; Educational Policy; Emerging Occupations; Employer Attitudes; *Employment Opportunities; Employment Patterns; Employment Potential; Employment Projections; *Futures (of Society); Job Skills; Labor Market; Labor Needs; Postsecondary Education; *Regional Planning; Salary Wage Differentials; Secondary Education; *Technical Education; Technical Occupations; Technological Advancement; *Technological Literacy
IDENTIFIERS United States (Northwest)

ABSTRACT

A study examined the views of leading Northwest business executives concerning the implications of and need for technological literacy in the 1990s and beyond. The executives made it clear that the United States is moving toward a future in which high-technology industries will alter work functions dramatically. Providing students with a basic core curriculum emphasizing an interdisciplinary approach appeared to be the most appropriate and feasible way of meeting the future demands of employers and of developing the adaptability necessary to cope in a rapidly changing technological environment. Interviews with employers in the three leading industries of the Northwest--wood/forest products, health/hospital services, and high technology--consistently revealed that orientation to keyboard and other computer skills will continue to be important for future workers. Cited just as frequently, however, were critical thinking, problem-solving, analyzing, and decision-making skills. It was stressed that schools must seriously address the relationship between liberal arts and technological literacy; continue to seek and upgrade qualified personnel in math, science, and vocational education; and increase state-of-the-art resources and equipment for academic and vocational courses alike. (Appendixes include a list of basic skills and competencies for productive employment and data summaries of the employer interviews dealing with the three aforementioned industries.) (MN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED270599

TECHNOLOGICAL LITERACY IN THE WORKPLACE

by

Leslie Crohn

Northwest Regional Educational Laboratory

300 S.W. Sixth Avenue

Portland, Oregon 97205

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

CE044585

September 1983

Education & Work Program
Northwest Regional Educational Laboratory
300 S.W. Sixth Avenue, Portland, Oregon 97204

This report is produced by the Northwest Regional Educational Laboratory, a private, nonprofit corporation. The work upon which this publication is based was performed pursuant to contract No. 400-83-0005 of the National Institute of Education. It does not, however, necessarily reflect the view of that agency.

ACKNOWLEDGMENTS

This publication represents a collaborative effort by the Laboratory's Education and Work Program and Computer Technology Program. Special thanks are extended to Michael Grice, a vice principal in the Portland Public Schools, for his interviewing of industry personnel during the summer, 1983. We also thank Charline Nemeth and Carol Davis for typing the manuscript and the following people for reviewing the draft:

Rex Hagans, Director of the Laboratory's Instructional Improvement Division

Bob Morse, Vice President, Marketing and Planning, Allied Data Systems, Olympia, Washington

Bruce D. Russell, Vocational Education Supervisor, Vancouver, Washington School District

Larry G. Selland, State Director of Vocational Education, Idaho

Ruth-Ellen Miller, Futurist, Portland

Wanda Silverman, parent

Susan Quattrociocchi, Washington Commission for Vocational Education

Wynn DeBevoise, Center for Education Policy Management, University of Oregon

Fred Nishimura, agriculturalist, Ontario, Oregon

TABLE OF CONTENTS

		Page
ACKNOWLEDGMENTS		I
EXECUTIVE SUMMARY		1
LIST OF TABLES		6
SECTION		
I.	WHAT IS TECHNOLOGICAL LITERACY?	7
	Defining High Tech	7
	The Future of High Tech in the Marketplace	9
	Skills for an Information Society	15
II.	IMPLICATIONS OF TECHNOLOGICAL LITERACY FOR EMPLOYABILITY SKILLS IN THE 1990s	17
	The Impact of Automation on the Work Force	17
	The Threat of Declining Math and Science Literacy	18
	Robotics	20
	Negative Side Effects of the New Technology	22
III.	TECHNOLOGICAL LITERACY AS A PART OF BASIC LIBERAL EDUCATION	25
	Reshaping Education to Meet the Demands of the New Technology	25
	The Role of Vocational and Industrial Education	28
	The Role of Computer Literacy	31
IV.	HOW EMERGING TECHNOLOGICAL CHANGES AFFECT JOBS IN LEADING NORTHWEST INDUSTRIES--SUMMARY OF INTERVIEWS	35
	Introduction	35
	Approach	35
	Common Responses Across All Industries	35
	Attitudes/Skills/Competencies Needed for Employability and Promotion	37
	Implications for Schools	38
	Open Response	40
V.	POLICY RECOMMENDATIONS	41
	Purpose and Goals	41
	Personnel	42
	Management	42
	Curriculum	43
	Resources	44
	Implementation	44

BIBLIOGRAPHY.....47

APPENDICES.....51

Appendix A: Basic Skills and Competencies for Productive Employment

Appendix B: Data Summary of Employer Interviews--Wood/Forest Products

Appendix C: Data Summary of Employer Interviews--Health/Hospital Services

Appendix D: Data Summary of Employer Interviews--High Technology

EXECUTIVE SUMMARY

Introduction

Current research clearly suggests that the future of our economy rests almost entirely on our ability to adapt and prepare for advancing technology. Some experts predict that our once unchallenged position as world authority in commerce, science, industry and technological innovation will continue to expand and become an integral part of homes, schools and work in the 1990s and beyond. Recent advances in telecommunications, computers and other science based concepts have resulted in new products, new R&D ideas and new approaches to marketing and selling. Until recently, the United States held a superior position in the development and utilization of technology--leadership that was directly attributable to a wealth of skilled salespersons, scientists, technologists and engineers. But this position of supremacy is disintegrating. We are experiencing a severe shortage of highly proficient scientists, engineers and technicians. We are threatened by an erosion of math and science literacy for the majority of our population and by ever-growing numbers of youth and adults who are barely aware that new machines and processes are opening new frontiers daily. Other industrial countries are becoming increasingly advanced as they develop and implement programs to broaden their technological capabilities. To maintain a stature of world power and influence, it is imperative that we equip our citizens with the skills to participate in an advancing technological society.

According to the National Commission on Excellence in Education, "Learning is the indispensable investment required for success in the "information age" we are entering (Commission Report 1983). Further, the report says, "The people of the United States need to know that individuals in our society who do not possess the levels of skill, literacy and training essential to this new era will be effectively disenfranchised, not simply from the material rewards that accompany competent performance, but also from the chance to participate fully in our national life."

One way to improve education in general, math, science and computer literacy in particular, and prepare young people for an emerging technological society is to provide students with experiences in the application of technological concepts in all grade and subject areas.

A report by the Task Force on Education for Economic Growth notes, "Technological change and global competition make it imperative to equip students in public schools with skills that go beyond the 'basics.' For productive participation in a society that depends ever more heavily on technology, students will need more than minimum competence in reading, writing, mathematics, science, reasoning, the use of computers and other areas (Task Force Report 1983).

The Purpose of the Study

No one really believes that advancing technology will replace workers in the future. More likely, we will work smarter, not harder. However, advancing technology is altering employers' perceptions of the workplace of the future and the type of worker necessary to compete in that marketplace. These emerging views of technological changes can be used to establish standards and direction for future education and training policies. As educators, we are faced with the challenge of responding to employers' needs and preparing young people to be creative and not just productive workers.

Through a literature synthesis and survey of leading Northwest business executives, we sought to answer the following questions:

- What is technological literacy?
- What implications does technological literacy have for new jobs and employability skills for the 1990s and beyond?
- How are demands for increased technology related to demands for excellence in basic skills and other areas of education?
- What are some new and emerging technological changes in Northwest industries that have implications for the work force and career preparation?
- What skills, attitudes and knowledge are employers looking for in workers?
- How can we best prepare young people for multiple careers and to cope with the process of change?

In the broadest sense, this study focuses on what schools and employers can do to help prepare young people and existing workers for the future. Understanding the implications of technological changes in the workplace will also provide an important base for those designing employment and training programs under the new Job Training Partnership Act (JTPA) and will provide input for considering new directions for the future.

What We Learned

We found consistent disagreement throughout the literature on the impact advancing technology will have on tomorrow's labor force. One group of researchers suggests that advancing technology will revitalize the nation's economy, resulting in a growth of high technology industries and a subsequent proliferation of jobs. Another group suggests that too much emphasis is being placed on technology's role in the marketplace and that "high technology" will account for only a fraction of future employment opportunities. According to these experts, most jobs will be in traditional occupations, not technical ones.

We found disagreement as to the outlook for wages in technology-related occupations. Some feel jobs in the computer field are the ones with the brightest prospects for higher salary levels. Others say jobs in computer and technical areas are greatly segmented, from software designers to data entry clerks. And while starting salaries are

correspondingly high for systems analysts and other high level experts, the competition for these jobs is intense. Currently, the vast majority of jobs are for lower level positions such as data entry clerks with pay scales of approximately $200 per week.

There was disagreement as to the number of jobs requiring low level skills as a result of advancing technology. One group says advancing technology will increase the number of jobs requiring minimal skill levels. Advancing technology will make work easier and reduce physical demands; fewer and simpler skills will be required. Another group of researchers suggests that technology will decrease the number of jobs requiring low level skills. As machines become more productive, they will eliminate many low level tasks. As a result, workers will need to upgrade their skills to qualify for higher level technical occupations. There will be fewer good-paying low-skilled manufacturing jobs left to divide among those who are poorly prepared.

We found further disagreement as to how to reshape educational institutions to meet the needs of business and an advancing technological future. One group, including members of the Task Force to Redefine the Associate Degree says the emphasis should be on technical aspects of education. Another group including researchers Levin and Rumberger of Stanford University suggests the emphasis must be on a liberal course of study.

Regardless of the opinion one holds in terms of advancing technology's impact on the labor force, we found that most researchers agree that technical skills will be important for future workers. Even for those individuals not pursuing a technical career, there will be great need to understand the basic principles underlying the technological devices that will pervade our culture to an even greater extent in the future.

However, of greater concern to those looking at ways to reshape educational institutions are the complex skills such as problem solving, analyzing, reasoning and conceptualizing. These "learning-to-learn" skills are those which our sources say are more important in helping students cope with a changing work environment. We came to the conclusion that individual needs require both a broad and a specialized curriculum with particular emphasis on the reinforcement and application of basic skills. The emphasis must be on providing a foundation that will enable people to learn over their lifetimes as new knowledge is needed.

This assertion is supported by an extensive review of the literature and results from a survey of executives from leading Northwest industries. These employers emphasized the need for strengthening basic skills rather than focusing on highly advanced or technical skills. Employers look for workers who can listen, think, communicate and get along with others. Future workers will need good thinking, comprehension and evaluative skills in order to understand the inner structure of systems, not just of specific duties. There is great evidence as to the increased interdependency of technology and communication; workers will need broad

perspectives to avoid narrowly focusing on any one set of responsibilities that will most likely change and quickly become obsolete.

The technical problems of the future will doubtlessly be handled via computer or other machine; it is far more important for the worker facing a problematic situation to draw on a repertoire of alternative responses. Adaptability seems to be the one essential ingredient in successfully coping with a rapidly changing technological environment.

Following are the major topical areas addressed in the study and a summary of significant findings:

1) What is Technological Literacy?

Based on extensive review and analysis of current literature, trends and attitudes, it is clear that we are moving toward a high technology future--one in which high technology industries will be dramatically altering work functions. In high technology jobs, people will interact with machines and electronic terminals. One purpose of our educational system is to provide all students with the math and science expertise and computer literacy they need to prepare for success in a marketplace where technology is pervasive. But perhaps even more important, educational systems need to provide students with the skills of analytical reasoning, logic and communications. This type of broad based educational foundation imparts both the skills required to perform in a high technology society as well as in a changing work environment. This preparation we shall call technological literacy.

2) Implications of Technological Literacy for Employability Skills in the 1990s

Young people need to be prepared to face alternativ working environments. Many employers and several national studies of education call for the development of higher level conceptual skills, including reasoning, analyzing, making inferences and problem solving--skills that are a direct result of rigorous study in any school subject. Effective instruction in math, science and computer applications will help students develop these higher level conceptual skills, particularly those achieving technical competence in secondary and postsecondary vocational programs.

3) Technological Literacy as a Part of Basic or Liberal Education

Future workers will face complex problems. To perform successfully in the marketplace, most workers will need to be resilient, versatile, independent and able to interact cooperatively and ethically with others. Providing students with a basic core curriculum emphasizing an interdisciplinary approach appears to be most appropriate and feasible for meeting the future demands of employers; adaptability is the one key

ingredient in successfully coping with a rapidly changing technological environment. A liberal course of study imparting general skills will provide workers in jobs deskilled by technology with the resources necessary to find other satisfactions in life.

In addition, skills, knowledges, understandings and values related to computers and information systems must be an integral component of educational programs. High priority must be placed on learning outcomes in computer literacy and integrated into existing math, science, social studies and language arts curricula.

4) How Emerging Technological Changes Affect Jobs in Northwest Industries

Interviews were conducted with employers and other personnel from three leading Northwest industries to determine the impact technology has had on the work force and how schools can best help students prepare for a technological marketplace. The survey consistently revealed that orientation to keyboard and other computer skills will continue to be important for future workers. However, cited just as frequently as skills young people must master were critical thinking, problem solving, analyzing, decision making and the ability to understand the nature and reality of work and employment.

Where Do We Go from Here? A Summary of Policy Recommendations

To strengthen the elements of technological literacy, the following policy recommendations are suggested:

- To promote technological literacy, schools should more clearly define goals and objectives related to mathematical, scientific and computer skills.

- Schools must seriously address the relationship between liberal arts and technological literacy. While schools must continue to provide a liberal course of study imparting general skills, technological literacy should be developed as a part of a liberal education.

- Schools must continue to seek qualified personnel in math, science and vocational education and upgrade existing faculty.

- A technologically literate society requires the combined efforts of schools, state and local officials including governors and legislators, the federal government, and business and industry. Principals, superintendents, school board members, state, local and federal officials as well as those from business and industry must play active roles if schools are to achieve goals in instructional improvement for technological competence.

- Schools must increase state-of-the-art resources and equipment for academic and vocational courses. A paramount recommendation here is the availability of computers for all students in all grade and subject areas.

- To work toward the goals of excellence in education and to provide quality instruction in computer and technological literacy, recommendations are made for a variety of activities that have potential for implementation including development of informational materials, use of human resources, strengthening of graduation requirements, examination of college entrance requirements, establishment of magnet programs, participation of female and minority students, development of teacher inservice programs and securing relationships with private sector organizations.

This study is a beginning step in the research and development of technological literacy necessary to adequately address the issues presented. Contact the Education and Work Program or Computer Technology Program at the Northwest Regional Educational Laboratory (NWREL) for further information.

LIST OF TABLES

Table		Page
1	Median Salaries for Selected Occupations.....	10
2	Jobs with the Most Openings, 1978-1990.....	12
3	Hottest Careers for the 80s.....	13
4	Jobs Directly Affected by Automation.....	21
5	Direct Job Creation in U.S. due to Robotics, by Occupation, 1990.....	22
6	Curriculum Design for Computer Literacy.....	33

I. WHAT IS TECHNOLOGICAL LITERACY?

Defining High Tech

High technology is the current rage in economic and education development and planning. However, there is virtually no agreement as to what high tech actually is. "Everyone talks about high technology, but ask them to define it. Most can't." says Eugene Strull, general manager of advanced technology at Westinghouse Electric Corporation's Defense and Electronic Systems Center (Business Week 1983). State and city officials, government labor analysts and even technology experts all use different terminology. Some local officials agree with James P. Penton III, executive director of Connecticut's new High Technology Council, who says high tech industry is "any industry that is going to create jobs in the 1980s and 1990s" (Business Week 1983). Strull, however, calls high tech industry any "industry with a high rate of change" (Business Week 1983).

As far back as 1967, Schon defined high tech as "any tool or technique, any physical equipment or method of doing or making, by which human capability is extended" (Schon 1967). Again in 1967, Perrow said high tech is simply "work done in organizations" (Perrow 1967). To show the evolution of the term, the most current definition given by the Bureau of Labor Statistics (BLS) says a high tech industry is "any industry where research and development expenditures and the number of technical employees runs twice as high as the average of all U.S. manufacturing" (St. Petersburg Times 1983). This would include makers of drugs, computers, electronic components, aircraft and laboratory equipment. Also qualifying would be such service industries as computer programming, data processing and research laboratories. The BLS defines 56 other industries as "high-tech intensive," meaning their R&D spending and technical employment are above the national average. Included here would be chemical industries, petroleum refining and the manufacture of textiles, printing, electrical and medical equipment.

For purposes of this paper, high technology industries are those which employ micro-chip technology in generating and processing products and services. A new publication, High Technology, more completely describes the fields directly influenced by or born of the technological revolution (Goldhirsh 1981):

- Genetic engineering. The technology associated with putting biological knowledge to work. Applications in the chemical industry, pharmaceuticals, agriculture.

- The electronic office. Multifunction work stations. Word-speech recognizers and simplified programming that will humanize the interface between people and machines. The costs, the benefits, the potential savings.

- Automotive technology. Improvement in auto engines that will save money and reduce emissions. Research to overcome the limitations of potential competitors to the internal combustion engine.

- Communications. Interactive television: the technology and its likely impact on entertainment, education, business, banking, retailing. Electronic mail. High-speed facsimile. Microwave links between offices. Teleconferencing.

- Construction. Energy-efficient architecture. Cost-saving materials. Labor-saving methods.

- Space technology. The Space Shuttle: how it will boost our capability to orbit satellites and even build space stations. New uses for orbiters--including navigation, geophysical exploration, crop studies, weather prediction.

- Energy. Thin-film photovoltaic cells and the promise of low-cost solar-generated electricity. Improved batteries and storage systems. The technology of fusion power and the obstacles that must be overcome.

- Military/aerospace technology. Rapid strike force equipment. Stealth aircraft. Passive detection systems. Automatic target recognition systems. Laser weaponry.

- Transportation. Light-rail vehicles. Magnetic levitation for high-speed trains. Computer-tracked fast freight. Hydrofoils. Dual-mode personal rapid transit.

- Medical technology. Implantable replacement body organs, artificial limbs, diagnostic devices, information retrieval and medical data systems.

- Robotics. The move toward fully-automated assembly lines. New machining methods. Energy-efficient production methods.

- New materials. Fiber-reinforced composites (carbon, boron, etc.) and "foamed" metals, which combine high strength with light weight. Inexpensive alloys that can substitute for more costly metals. Superconductors. New coatings, adhesive and other materials.

- Measurements. New tools for measuring a wide range of phenomena. High-speed observation of dynamic processes, chemical reactions, subatomic particles. Cosmological observations.

- Personal computers. What's new and what's next. What they offer and how they can be used. Advances which will make them more useful, more popular.

- Artificial intelligence. Machines that think for themselves--or for you.

High technology in the broadest sense of the term is therefore, state-of-the-art technological advancements which are affecting and dramatically altering the world of work as we know it. High tech, seen

in this way, is a multibillion dollar enterprise and a major contributor to our national economy. Communities look to clean, labor intensive high tech industries to boost their own sagging economies. Policy makers envision a growth in jobs as a result of increasing high technology in the workplace--jobs that will revitalize the nation in a worldwide market. And workers are seeking the retraining that will help them qualify for and meet the demands of high technology jobs. "It's a great bandwagon business," says April Young, executive director of the Fairfax (VA) Economic Development Agency. "There are 4,500 economic-development agencies in this country, and it's fair to say that every one of them is after high tech" (Business Week 1983).

The Future of High Tech in the Marketplace

It is clear that more and more attention is being paid to the growth and proliferation of industries that manufacture programmable and other electronics-oriented technological devices. Computers and computer-controlled equipment have become an integral part of homes, factories and offices. The BLS predicts that the computer industry will lead all others in terms of economic growth and output through the next decade. One estimate suggests that by the year 2000, millions of jobs will involve laser technology and robots. Anita Gates, author of 90 Most Promising Careers for the 80s agrees with these figures and says that today the two fastest growing job fields in her perspective are high technology and health care. However, Gates' definition is more than expansive as she feels "technology is everywhere" (St. Petersburg Times 1983). Other experts predict that such fields as optical and scientific equipment will be among the fastest growing manufacturing industries of the immediate future.

Conversely, there is evidence to suggest that perhaps too much emphasis is being placed on the speed and impact these manufacturing industries will have in penetrating the current work force. In spite of their spectacular growth, new high tech industries will account for only a fraction of total U.S. employment by the 1990s. It is the view of the Commission on Employment Policy that high tech will comprise only 4 percent of all jobs in 1990. At present, high tech industry is the fastest growing segment of our overall national economy, but it does not as yet, and by any means, dominate the labor force. Howard Crane, senior vice president of MCI Communications Corporation says, "the number of high tech jobs created in the next decade will be less than half of the two million jobs that have been lost in manufacturing in the past three years." Crane adds, "high tech will change the way work is performed, and where it is performed, but it will not, for the most part, in my opinion, change careers" (St. Petersburg Times 1983).

In spite of a consistently high unemployment rate, at present more than 99 million Americans are working. While some people have not been affected by the recession, others have had to scramble to seek new jobs. What workers are earning varies greatly even within the same occupation. Factors which influence wages include the size of the community, the size of the company, the region of the country where the company is located,

the sex of the worker (women are still paid less than men for the same job) and, perhaps most important, supply and demand. The computer industry is a prime example of this supply and demand factor as it affects the job market. While advancing technology has created a whole new field of occupations--systems analysts, data base specialists, programmers and so on--it has also dramatically changed the nature of many jobs and eliminated others. One estimate suggests that the demand for skilled workers in the computer field will increase by 47 percent by the year 2000 and triple the average growth rate for all other occupations (Kandel 1983). Salary rates for many experts are increasing in proportion to the demand: "A programmer at a medium-size company can earn $18,000-$21,000, while a telecommunications specialist in a large company can make as much as $32,000 and a data base administrator up to $36,000. The men and women who repair data processing machines earn more than $20,000 a year (Kandal 1983).

Comparing these figures with the median salary range for other occupations finds them among the highest for all wage earners as shown in the following table.

TABLE 1
MEDIAN SALARIES FOR SELECTED OCCUPATIONS

Engineer	$25,000+
Physician	$25,000+
Dentist	$25,000+
Administrator	$23,375+
Foreman	$22,760
Science technician	$20,523
Construction worker	$20,451
Miner	$20,265
Machinist	$18,953
Sales worker	$18,131
Teacher (except college)	$16,971
Delivery worker (transport)	$16,762
Carpenter	$16,564
Auto mechanic	$16,321
Bookkeeper	$12,607
Secretary	$12,060
Farmer	$12,209
Household worker	$5,298

Source: U.S. Department of Labor Statistics, 1983

Yet data processing and other technology related occupations have not been completely untouched by the ravages of the recession as witnessed by cutbacks in entry-level hiring and the intense competition for available jobs.

Though some see the computer field as a vast marketplace of high paying jobs, many experts say it is really a field of greatly segmented

occupations requiring a wide range of skill levels. The BLS breaks down occupations in the computer field into systems analysts, programmers, computer operators, service technicians and keypunch operators. In addition, there are the various designers: software engineers, electronics engineers, solid state technicians and others.

And while starting salaries for systems analysts can go as high as $600 per week, keypunch operators (also known as "data entry clerks") are more likely to receive $227 per week for feeding data into those computers. John Dunn, in writing about computer jobs says, "Graduates of computer science programs at four-year colleges have few problems finding employment. Those with master's degrees usually can take their pick of several job offers, and the few hundred people who earn computer-related doctorates every year can find many employers eagerly bidding for their services. But many prospective programmers, technicians, systems analysts and computer operators who have completed one- or two-year programs at the nation's community colleges and technical schools are finding they must scramble for work" (Dunn 1983).

Tom Nardone, an economist with the BLS adds, "What people in two-year programs are running into is a tight job market and competition from people in four-year programs" (Dunn 1983). Part of the problem is the large number of math, business and engineering graduates going after the same computer-related jobs.

Many experts believe that most of the new jobs will be in traditional occupations, not in technical ones and that less than one-third will be for engineers and technicians. The U.S. Department of Labor reports in their Occupational Outlook Quarterly, that the following jobs will be the ones with the most openings into the next decade and beyond. We suggest, however, that most of these occupations will require workers to use advancements in technology.

TABLE 2
JOBS WITH THE MOST OPENINGS, 1978-1990

Occupation	Annual Openings	Possible Applications of Advancing Technology
Secretaries/Stenographers	305,000	Using word processors
Retail Sales Workers	226,000	New products
Building Custodians	180,000	Using technology systems
Cashiers	119,000	Using computerized cash registers
Bookkeeping Workers	96,000	Using computer systems
Nursing Aides, Orderlies and Attendants	94,000	Observing monitors
Kindergarten and Elementary School Teachers	86,000	Using computer assisted instruction
Registered Nurses	85,000	Using new health care systems
Assemblers	77,000	Using automated systems
Waiters and Waitresses	70,000	Using computerized cash registers
Guards	70,000	Using telecommunications equipment
Blue-Collar Worker Supervisors	69,000	Using office computer
Accountants	61,000	Using computerized equipment
Licensed Practical Nurses	60,000	Keeping updated on skills
Typists	59,000	Using word processors
Carpenters	58,000	Using laser technology
Industrial Machine Repairers	58,000	Using computerized monitors
Real Estate Agents and Brokers	50,000	Using computerized listings
Construction Laborers	49,000	Understanding systems designs
Engineers	46,500	Designing computerized equipment
Bank Clerks	45,000	Using computerized data bases
Private Household Workers	45,000	Using home computers
Receptionists	41,000	Using telecommunications equipment
Wholesale Trade Sales Workers	40,000	Selling computerized equipment

Source: Occupational Outlook Quarterly, U.S. Department of Labor, 1983
Note: Replacement needs and growth are projected to cause these occupations to offer the largest number of openings. Competition for openings will vary by occupation.

While advances in communications and information processing are occurring and resulting in a gradual reorganization of jobs and work functions, educational systems are only beginning to respond: "...years of neglect in the U.S. educational system have already put a serious crimp in the supply of scientists and engineers needed to drive high technology (Business Week 1983).

The initiation of the information society has its roots in two events: (1) white-collar workers in technical, managerial positions outnumbered blue-collar workers for the first time in 1957, an event which signified that more people were working with information than were producing goods, and (2) the Russians launched the first satellite in 1957, thereby inaugurating the era of global satellite communications (Lofquist 1983). This shift in power from the production of goods to the development and dissemination of information has serious implications for those community people who make political and economic policy. One task of educators is to help young people prepare for change and successfully respond to the demands of an advanced technological future. This education is most appropriately called technological literacy.

Some research suggests that occupational growth throughout the 1990s will expand most rapidly in the higher skilled technical occupations. For example, a Fox-Morris survey, "1980s U.S. Job Market" finds the following occupations to be among those with the highest projected salaries for the 1990s:

TABLE 3
HOTTEST CAREERS FOR THE 80s

Career	Projected Average Salaries by 1990
Data Processing	
Programmer	$33,000-$43,500
Systems Analyst	$38,000-$52,500
Data Base Manager	$49,500-$67,000
Engineering	
Mechanical	$33,500-$47,000
Electronics	$35,300-$49,000
Energy	$44,000-$60,500
Accounting & Finance	
Cost Accountant	$34,700-$46,000
Auditor	$34,900-$48,000
Financial V.P.	$80,000-$115,000
Human Resources/Personnel	
Technical Jobs Recruiter	$31,500-$43,800
Personnel V.P.	$70,000-$95,000
Marketing & Sales	
Sales Engineer	$34,000-$47,500
Secretary	$15,100-$28,900

Source: Fox-Morris "1980s U.S. Job Market" Survey

This study and others suggest that students must be adequately prepared for future learning and employability through increased emphasis on those "higher" level skills that encompass technological competence. That students may not be adequately prepared to cope with these future employability competencies is one interpretation of data gathered by the National Assessment of Educational Progress (NAEP). NAEP reveals that minimum skills are demonstrated successfully by the majority of 17-year-olds across the country, but only a minority of these students are able to satisfactorily demonstrate higher order skills. And it is those higher order skills that many feel will be the integral components of technical occupations. These deficiencies have led some researchers to reach some sobering conclusions. Paul Hurd, educational researcher, conducted a thorough national survey of student achievement as it relates to the scientific revolution. His conclusion: "We are raising a new generation of Americans that is scientifically and technologically illiterate" (Commission Report 1983).

Secretaries today work with word processing equipment, bookkeepers work with computerized record systems, mechanics use diagnostic equipment employing microcomputers and telephone operators rely on computerized directories. Electronic cash registers and inventory control equipment are standard. It is therefore appropriate that educators and policy makers respond with curricula to effectively prepare young people for coping with such technological advancements in the workplace. According to Gene Bottoms, Executive Director of the American Vocational Association, "...the extent to which we can utilize high technology and translate it into better products and increased productivity depends upon the availability of people who can apply it, maintain it and service it. These people are not the scientists and the mathematicians--they are the advanced-level skilled workers" (Bottoms 1983). Similarly, Donald N. Frey, chief executive officer of Bell and Howell Company, has made the point that if we expect to translate state-of-the-art technology into improved production capacity, we must have the advanced-level technical workers to effect this transformation (Bottoms 1983).

Other research that speaks to the need for technological literacy addresses the social and economic consequences of a high unemployment society. Rising unemployment can have a devastating effect on the economic well-being of any industrialized nation; increased numbers of workers become discouraged, decaying cities lose their populations, crime increases, welfare costs escalate, tax revenues are lost and societal morale in general erodes. However, advancements in technical knowledge have not substantially remedied the high unemployment rate. While many blue-collar workers have been displaced (32 percent since December 1980), severe labor shortages exist for the advanced-level technical occupations.

By 1990, the unemployment rate is expected to decrease. But many displaced workers will not be able to return to their former occupations. In an advancing technological society, unemployment will more likely result from the lack of skills and knowledge than from the lack of job opportunities. Our schools and colleges send a million and a half new workers into the economy each year. In addition, 75 percent of

working adults today will still be a part of the work force in the year 2000. These workers will require the education and retraining necessary to maintain a position of employment throughout their lifetimes in a high tech society.

Skills for an Information Society

Much of the research delineates those skills felt necessary for employability in tomorrow's labor force. Following are examples of these skills, written as possible job descriptors and reflective of an information society:

- Demonstrate competence including precision and accuracy with computer, basic electronics, other peripheral equipment
- Prepare and enter information input for computer and other hardware; understand what is necessary for a computer to accept new information or respond to a request
- Maintain and manipulate files of technical information and perform other systems operations
- Demonstrate competence with analog devices such as potentiometer
- Demonstrate competence in networking, data accessing
- Develop and evaluate software
- Monitor work flow of production systems

These examples are obviously technical in nature and representative of those skills that may become more widespread across all industries. However, there is also a substantial body of information which places overriding importance on new kinds of "basic" skills for tomorrow--skills which may be considered higher level now but will eventually become the basics of the future. Advancements in technology are quickly altering our perceptions of "basic skills" or those that are necessary for economic survival. The Task Force on Education for Economic Growth reports, "The stiffening demands of advancing technology will almost certainly mean that real opportunity, real chances for upward mobility, will increasingly be reserved for those with 'learning-to-learn' skills. Not just the ability to read, write and compute at a minimum level, but more complex skills of problem solving, reasoning, conceptualizing and analyzing. Increasingly, people who have only today's basic skills--or less than today's basics--will be consigned to economic stagnation" (Task Force Report 1983).

Basic skill advocates say technical skills will evolve, change and quickly become obsolete, but basic skill acquisition allows young people to cope, adapt and provide for their own retraining and lifelong learning.

A considerable portion of the literature suggests that we must upgrade our concept of basic skills to include those that will be demanded of workers in tomorrow's technological workplace. Basic skills of the future will be those that impart the skills of analysis and problem solving that constitute "learning-to-learn" skills.

Many experts feel the following skills remain of paramount importance and are the ones young people must master for the future:

- Self-discipline; responsibility for one's actions
- Respect for others
- Social responsibility and resources conservation
- Comprehension, drawing conclusions
- Problem solving, critical thinking, logical thinking
- Communications skills
- Moral and ethical standards
- Evaluation and analysis skills
- Creativity
- Decision making
- Synthesis and application skills
- Organization and reference skills

(Note: Appendix A lists the basic skills and competencies necessary for employability as endorsed by the Task Force on Education for Economic Growth.)

Summary

It is clear that two alternative views on how the new technology will affect future job skills are emerging. The first view focuses on the machine as master; the machine will perform the majority of complex tasks. Technology in the workplace will make work easier by reducing physical demands. Therefore, there will be an increase in the number of jobs requiring minimal or low level skills. An example of this is the user friendly computer. Many computers now and more in the future will be voice activated, eliminating many of the traditional keyboarding functions. Fewer and simpler skills will be required to manipulate technical machinery and equipment.

The opposing view sees a decrease in the number of jobs requiring low level skills; as machines become more efficient and productive, they will eliminate many low level tasks. As a result, many workers will need to upgrade their skills to qualify for higher level, technical occupations. In the future, there will be fewer good-paying, low-skilled manufacturing jobs left to divide among the many who are poorly prepared. Therefore, low-skilled and undereducated most likely means unemployment or just barely employed.

II. IMPLICATIONS OF TECHNOLOGICAL LITERACY FOR EMPLOYABILITY SKILLS IN THE 1990s

The Impact of Automation on the Work Force

That tomorrow's labor force will differ significantly from today's in terms of skills and training required for employability and success on the job is an accepted fact. Experts estimate that as many as 45 million existing jobs will be seriously altered or eliminated by factory and office automation, and most of this by the year 2000 (Business Week 1983).

Item: According to Business Week, "The rapidly developing drive toward the workerless factory--and the automated but still populated office--will affect American jobs and jobholders on a scale unprecedented in modern times. Scholars of automation do not expect this rapid substitution of machinery for human labor to increase unemployment, assuming healthy economic growth. But they do expect a radical restructuring of work, including a devaluation of current work skills and the creation of new ones at an ever-increasing rate. This will result in a fundamental change in most work places and an often painful adjustment for the workers involved. These changes will require employers to retrain huge numbers of workers. Ultimately, the nation's education system will have to prepare future workers for functioning in an electronic society" (1981).

Item: Harvard University economist James L. Medoff has estimated that as much as 60 percent of the drop in productivity in this country over the past decade can be attributed to an imbalance between the requirements of the job and the skills people have. Medoff says the reason for this is that people are not being adequately trained. According to Medoff, since 1969, just slightly more than 4 percent of the work force over 17 years of age has received training and the time allotted for that training has, on the average, amounted to only 10 hours (Bottoms 1983).

Item: One study found that students from competing countries have had about three times the amount of training in their occupational areas than our students have received. These students also were found to have more training in math, science and other technical areas and the chance to rotate through a variety of learning experiences in the workplace (Bottoms 1983).

Item: A recent study of job skill requirements in Tennessee found employers reporting a major shortage of workers with skills in installation, maintenance and operation of modern production machinery (Bottoms 1983).

Item: A 1983 Gallup survey for the Century Insurance Company found that the major concern of 1200 metal precision employers was where they were going to find the journeyman level workers they need once the economy begins to turn around. In the past, they have had to resort to enticing workers away from each other. According to the President's Council of

Economic Advisors, a major factor fueling inflation in the 1970s was employers bidding against each other for skilled workers.

The data are clear: young people need to be prepared to face alternative working environments. The factory of the future will comprise emerging technological components of today: flexible manufacturing systems, flexible manufacturing cells, robots and computers. As the knowledge base continues to expand, the number of traditional jobs will decline and new jobs created will demand greater preparation and sophistication. Experts fully agree that microelectronics will have a tremendous impact on factories, offices and individuals. Automation will upgrade many jobs to managerial status, but it will also displace workers who now perform routinized tasks. The jobs most likely created by automation will be those that require humans to babysit equipment. Unions will have to address new labor conflicts as they lose their blue-collar memberships to automation. A study conducted last year at Carnegie-Mellon University found that robots could perform about 7 million existing factory jobs--45 percent of which are now covered by union contracts (Business Week 1983).

The advanced level worker's job will be to troubleshoot, see problems, identify causes to those problems and then recommend or perform the necessary corrections. These tasks will require an understanding of the technology, clear and logical thinking and skills with tools and communications. Increased emphasis in math and science will help young people gain those competencies.

To adequately prepare young people for such advanced level technical occupations, educational policy makers need to seriously examine applied math and science components in educational institutions. They need to critically study the relationship between math and science and technological literacy. The shortage of advanced level skilled and technical workers will continue to escalate until national and state policy makers recognize the problem and do something about it.

The Threat of Declining Math and Science Literacy

The data overwhelmingly suggest a steady decline in mathematical and scientific literacy over the last two decades, as evidenced by the reduced numbers of students participating in these courses and decreased levels of achievement. Most secondary students do not pursue math and science courses after the first year. And yet research points to an increasing number of occupations that will require applications of mathematics and science such as automobile mechanics, retail sales personnel and environmental specialists in addition to the more obvious occupations of scientists, engineers and mathematicians. It is becoming more and more apparent that technological literacy will be an important factor in achieving success on the job and participating fully and effectively as a consumer and citizen.

One important need of young persons preparing for future occupational goals is the development of higher-level conceptual skills including

reasoning, analyzing, making inferences and problem solving--skills that can be a direct result of rigorous study. And while many courses help students develop higher-level conceptual skills--such as the study of foreign language, history and government--math and science courses are also important, yet often neglected, areas. Effective instruction in vocational education must include an emphasis in math and science--instruction that has obviously not been given priority in recent years. The following data are given in evidence as to the severity of the problem (ECS Report 1982):

- Between 1960 and 1977, the proportion of public high school students enrolled in science and mathematics courses declined; the number of students enrolled in science declined from 60 to 48 percent.

- Despite recent increases in mathematics and computer science enrollments, one-half of all high school graduates in the U.S. take no mathematics or science beyond the tenth grade.

- Mathematics and science achievement, as measured by successive national assessments throughout the 1970s, have shown a steady decline. This decline has been least for 9- and 13-year old age groups with increasing deficits for 17-year-olds.

- The effect of insufficient quality of mathematics and science preparation in the elementary and secondary schools is revealed by the fact that remedial mathematics enrollments at 4-year institutions for higher education increased 72 percent between 1975 and 1980--compared to a 7 percent increase in total student enrollments for the same period.

- Scores on the Scholastic Aptitude Test (SAT) for approximately one million college bound students have declined over an 18-year period through 1980. The mean score in mathematics dropped from 502 in 1963 to 466 in 1980.

Additional data are documented by the National Commission on Excellence in Education (1983):

- Intermediate algebra is offered in secondary school curricula but only 31 percent of high school graduates complete it.

- Where calculus is offered in schools, only 6 percent complete the course.

- In other industrialized nations, "courses in mathematics (other than arithmetic or general mathematics), biology, chemistry, physics and geography start in grade 6 and are required of all students. The time spent on these subjects, based on class hours, is about three times that spent by even the most science-oriented U.S. students, i.e., those who select 4 years of science and mathematics in secondary schools."

- Thirty-five states require only one year of mathematical study; 36 states require only one year of science for a diploma.

Speaking to these data, John Slaughter, former Director of the National Science Foundation, warns of "a growing chasm between a small scientific and technological elite and citizenry ill-informed, indeed uninformed on issues with a science component" (Commission Report 1983).

The study of science in high school will help students understand the laws, processes and concepts of physical as well as biological science. It will help students acquire skill in scientific inquiry and reasoning and how to apply scientific knowledge to everyday life. The rigorous study of science will help students become familiar and comfortable with the social and environmental implications of scientific and technological advancements, especially as they relate to the marketplace.

Furthermore, computer science should be a part of secondary curricula. Study in this discipline will assist young people in understanding the computer as an information, computation and communications tool; it will allow students to use the computer to study other disciplines, for work-related purposes or for personal satisfaction. Every teacher should have a computer at deskside, not just for instructional purposes but to model its use as a work tool as well. And finally, study of computer science will help young people understand how computers, electronics and other technologies will most likely affect them in the future.

Robotics

Robotics will have a definite impact on the workplace of tomorrow. Though U.S. industry has been in a state of decline since the proliferation of low-cost, high-quality imports, it is once again beginning to automate at an every-increasing pace. Many experts predict that by 1990, the U.S. will surpass Japan and Germany in the race to automate and will again take the lead in industrial productivity. Soon to be prominent are computer controlled systems of robots and other machinery that will replace many workers and produce unparalleled growth in productivity.

But experts disagree as to the effects robots and other technological advancements will have on American industry. There is disagreement as to how many jobs will be created or eliminated as a result. Some consensus is emerging, however, which indicates that industrial workers will have to learn new job skills to keep up with their mechanized competitors. The following table displays the jobs that will be directly affected by automation.

TABLE 4
JOBS DIRECTLY AFFECTED BY AUTOMATION

In factories	Number of employees	In offices	Number of employees
Assemblers	1,289,000	Managers	9,000,000
Checkers, examiners, inspectors, testers	746,000	Other professionals	14,000,000
Production painters	185,000	Secretaries, other support workers	5,000,000
Welders and flame cutters	713,000	Clerks	10,000,000
Packagers	626,000	TOTAL	38,000,000
Machine operatives	2,385,000		
Other skilled workers	1,043,000		
TOTAL	6,987,000		

Source: The Impacts of Robotics on the Workforce and Workplace, Carnegie-Mellon University: Booz, Allen & Hamilton, Inc., 1983

By 1990, 80,000 to 100,000 robots will be in use, according to Walter Wiesel, president of the Robot Institute of America, a trade association and PRAB Robots, a manufacturing firm (Education Daily 1983). However, that prediction can only be accurate if there is a complete turnaround in U.S. economic trends and workers are provided with massive retraining efforts to help them cope with the new robot technology.

Other figures are more conservative regarding the robotic revolution. Allan Hunt of the Upjohn Institute predicts that 50,000 to 100,000 robots will be in use by the end of this decade (Education Daily, 1983). Hunt feels it is the unskilled and semiliterate workers who will experience the greatest job loss. He adds that 32,000 to 64,000 new jobs will be created in robot manufacturing, supply, engineering and use. But he also warns that over half the jobs created by robotics will require two or more years of college level training. Wiesel agrees with Hunt's assessment on the amount of training necessary for robotic technicians. He says the typical worker in this area will be a person who "understands what the arm is supposed to operate like at the job site."

Table 5 displays the types of jobs created by advancements in robotics.

TABLE 5
DIRECT JOB CREATION IN U.S.
DUE TO ROBOTICS, BY OCCUPATION, 1990

Occupation	Employment Range of estimate Low	High
Engineers	4,636	9,272
Robotics technicians	12,284	24,568
Other engineering technicians	664	1,328
All other professional and technical workers	936	1,871
Managers, officials, proprietors	1,583	3,166
Sales workers	581	1,162
Clerical workers	2,908	5,817
Skilled craft and related workers	2,163	4,326
Semiskilled metalworking operatives	2,153	4,306
Assemblers and all other operatives	3,763	7,526
Service workers	138	2,776
Laborers	279	558
Total	32,088	64,176

Source: W.E. Upjohn Institute for Employment Research, 1983

While community colleges are quick to begin providing the necessary training, they may be overdoing it. Hunt says, "Specifically, a continuation of the expansion of the last year or so in course offerings and enrollments in robotics technician programs on a national scale will very quickly swamp the ability of the industry to absorb trained people" (Education Daily, 1983).

According to Peggy Canada, a Cox Cable Communications executive, secondary schools are not adapting quickly enough to this new field. She says, "Robotics and smart machines are going to require chief maintenance technicians who will replace wrenches with computer terminals and troubleshooting programs." But she adds, "where are the high school courses to begin (to meet) this educational need?" (Education Daily 1983).

Canada calls for more math and science courses along with traditional skill training, to catch up to the training being offered and provided by industry. In the final analysis, where robotics is concerned, young people need good information on the future of the labor market so as to make informed decisions about the direction of their own job training.

Negative Side Effects of the New Technology

A major problem facing corporations in admitting the new technology into the workplace is fear. New equipment can be seen as menacing and threatening. And it's not just secretaries who harbor resentment against the machines they see as threats to their jobs. Many executives also resist the technology as too demeaning or not worthy of their time. Ted Stout, of National Systems, Inc., an office design firm, says, "The biggest problem in introducing computers into an office is management itself. They [executives] don't understand it, and they are scared to death of it" (Time 1983).

Other executives manifest their fears differently. They feel they will be pushed out by the machines and those who can manipulate them if they don't gain the necessary skills quickly. Harold Todd, executive vice president at First Atlanta Bank says, "Managers who do not have the ability to use a terminal within three to five years may become organizationally dysfunctional" (Time 1983).

The role of management in allaying the more negative side effects of automation is crucial. Future technologies will continue to simplify and routinize work functions making it more difficult for workers to express creativity or individuality. Extensive retraining programs will be necessary to combat workers' fears and reluctance in entering the technological age. Workers tend to express great skepticism when machines are introduced into their occupational areas. Management must be able to create an atmosphere that allows workers to talk about their feelings. At General Motors, for example, managers and workers meet regularly to discuss new assembly-line technology and analyze how it can be applied to give workers a greater sense of responsibility on the job. Managers of the future wil have to identify, understand and implement solutions to general as well as specific problems. Management will have to be as knowledgeable about the arts and humanities as about technical and social sciences. Management education, therefore, will have to encompass the best of lifelong learning principles.

III. TECHNOLOGICAL LITERACY AS A PART OF BASIC OR LIBERAL EDUCATION

Reshaping Education to Meet the Demands of the New Technology

There is substantial disagreement as to how to reshape our educational system to better meet the needs of business and a high tech future. The National Task Force to Redefine the Associate Degree, in looking at the impact of high technology on the community college, said in its report, "High technology is not only affecting the curriculum but is precipitating an institutional metamorphosis, and refusal to acknowledge this phenomenon can result in deterioration of preparation for careers in technical areas" (Education Daily 1983).

Two factions are emerging. The first says the answer lies in increased emphasis placed on vocational education, career education, science and math studies and the use of microcomputers. This group emphasizes the technical aspects of education to help prepare young people for the future marketplace. Social scientists in this cadre believe that the new technology increases differentiation and specialization of labor; high tech affords workers greater levels of responsibility and demonstration of skills. Therefore, school curricula should accommodate those demands for increased knowledge and skills necessary for the design and use of the new technology. The Task Force found in their survey of community colleges that 71 percent of those institutions said "high technology has already influenced their curriculum and that new programs should be developed." The report went on to say that two-year colleges should "cement their ties with business and labor to keep training programs relevant and faculty members up to date."

The second group feels a liberal course of study is the answer--academic curriculum emphasizing the arts and the humanities can best prepare young people to adapt to a rapidly changing society. A liberal course of study, imparting general skills, will provide workers in jobs deskilled by technology with the resources necessary to find other satisfactions in life.

These diverse views on how to reshape education to best prepare young people for an emerging technological society are not really mutually exclusive. Individual needs of students require <u>both</u> a broad and a specialized curriculum, with particular emphasis on the reinforcement and application of basic skills. A strong case can be built for developing technological literacy as a <u>part</u> of liberal education.

Following a conference on technological literacy sponsored by the Alfred P. Sloan Foundation, education writer and researcher Stephen White made a statement calling for a new direction in liberal arts education--one with an orientation toward technological literacy and basic skills. In his essay, "The New Liberal Arts," White says, "To believe in this era, that a person possesses a liberal education who is ignorant of analytic skills and technological skills is to make a mockery of the central concept of liberal education and to ignore the nature of

the world in which the graduate will live, and to which [he or she] hopes to contribute in one way or another" (White 1981).

Henry M. Levin and Russell W. Rumberger, researchers at Stanford University also advocate the development of a general curriculum. They believe fewer, not more, job skills will be necessary for the technological age. Levin and Rumberger say the implications of high technology are that a solid basic education, rather than a narrow vocational focus, will become even more important, not less important, in the future:

> ...the expansion of the lowest skilled jobs in the American economy will vastly outstrip the growth of high technology ones; and the proliferation of high technology industries and their products is far more likely to reduce the skill requirements of jobs in the U.S. economy than to upgrade them. Nonetheless, the educational system should strengthen the analytical and communicative skills of students, not because of the needs of high technology, but because such skills will help them deal with the changing political, economic, social, and cultural institutions they will face in their adult lives (Levin and Rumberger 1983).

These two social scientists feel that the emphasis must be on providing a foundation that will enable people to learn over their lifetimes as new knowledge is needed. Strong analytic, expressive, communicative and computational skills will need to be taught for their own sake in addition to helping individuals adjust to an advancing technological future.

White feels that a fundamental purpose of liberal education is to make one familiar and comfortable with one's culture as well as with the cultures of other peoples. A liberal education must, therefore, reflect the changing needs of those cultures. Since technological changes will have a significant impact on the world in which we live, it becomes imperative for policy makers and educators to respond with appropriate changes in our educational programs (White 1981). An overemphasis on technical skills must be avoided; little time would be left for the study of the arts and humanities which lead to human civility and a sense of community and self-worth. Instead, the humanities must be closely tied to science and technology so as to retain human creativity and relevance of the human condition.

In support of Levin and Rumberger's thesis is the work done by Harry Braverman, Ivar Berg and others (R&D Center Report 1982). The contention of this group reinforces the concept that technology will most likely lower the skills required for the majority of jobs. Berg studied the educational and training requirements estimated for 4,000 jobs; he used data from 1957 and 1965. Berg compared these data with educational achievements of the work force by occupation. He concluded that "since achievement appears to have exceeded requirements in most job categories, it cannot be argued helpfully

that technological and related changes attending most jobs account for the pattern whereby better educated personnel are required and utilized by managers" (R&D Center Report 1982).

Braverman makes the point that managers find it more cost effective to routinize skills. He says that technological changes in industry and business result in a dichotomy of skills for managers and workers. The managers are the ones whose skills are upgraded and reflective of the new technology while workers lose more and more control and understanding of the machines they operate. An example of this is the job of typing. In the past, typing has required such skills as manipulating a keyboard, changing paper, checking for spelling errors, performing layout tasks and so on. With the advent of word processors, most of this work is now done automatically by the machine. The word processor deskills typing tasks through spelling correction, text centering, layout and so on. Though workers must still possess some skills for keyboard manipulation, word processors will eliminate most other levels of accuracy.

The points made by Levin, Rumberger, Braverman, Berg and others were reinforced by the interviews conducted during this study. Employers emphasized the need for a strengthening of basic skills, rather than focusing on highly advanced or technical skills. Employers look for workers who can listen, think, communicate and get along with others. A study done by Richard Riche (1982) found that the technological impact on jobs has resulted in an emphasis on knowledge, precision and perceptual attitudes--all skills that stem from a functional competence in reading and writing. Basic skills in reading and writing allow for the interpretation of complex operating manuals for machines and equipment in addition to the ability to retrain for career redirections.

The Education Commission of the States (ECS) compiled a list of skills that should be mastered by future workers (1982). This work was based on a study of those skills found necessary for participation in modern society.

According to ECS, the "basics" that must be mastered by future workers include:

- Evaluative and analytical skills
- Critical thinking
- Problem solving
- Organizational and reference skills
- Synthesis
- Application
- Creativity
- Decision making (with incomplete information)
- Communication skills (using a variety of modes)

It is also apparent from the literature that the skills required by a technological society will include effective processing of information. Even for those individuals not pursuing a technical career, there will be

need for an understanding of the basic principles underlying the technological devices that have pervaded our culture. Future workers will need good thinking, comprehension and evaluative skills in order to understand the inner structure of systems, not just of specific duties. There is great evidence as to the increased interdependency of technology and communication; workers will need broad perspectives to avoid narrowly focusing on any one set of responsibilities that will most likely change and quickly become obsolete.

Future workers will face complex problems. To perform successfully in the marketplace, most workers will need to be resilient, versatile, independent and able to interact cooperatively and ethically with others. The technical problems will doubtlessly be handled via computer or other machine; it is far more important to the worker facing a problematic situation that he or she posses a repertoire of alternative responses. Adaptability seems to be the one essential ingredient in successfully coping with a rapidly changing technological environment.

Providing students with a basic core curriculum emphasizing an interdisciplinary approach appears to be most appropriate and feasible for meeting the future demands of employers, For example, Elting Morrison proposes a new course of study in liberal arts. He feels that these programs should involve students in tackling the most difficult problems facing society, for example, nuclear energy, genetic engineering, space exploration and others. Morrison believes these problems all have their roots in technology (Morrison 1981):

> ...they all lead out to every corner of human endeavor--economic arrangement, political structures, institutional design, communication networks, social organization, and the condition of individual lives. They also raise for review the timeless concerns--the relation between thinking and doing, the boundaries of appropriate scale, the proper claims of aesthetics, and the difficulty of choice among both practical and moral considerations.

A general curriculum emphasizing critical thinking skills and problem solving abilities allows for problem identification and definition. A broad educational curriculum will provide students with the ability to adapt to change.

The Role of Vocational and Industrial Education

The current goal of industrial education is to develop technological literacy as a component of a broad based general curriculum (Foster 1983). This has not always been the case.

In the past, researchers have raised some serious questions as to the effectiveness of vocational education and career education programs. They have criticized the narrow focus of these programs which appear to lack the development of critical thinking skills. Employment records for vocational education graduates are not significantly better than for

general education graduates--obviously due, in part, to a tight labor market, but also, perhaps as a result of the skills being taught in vocational education programs becoming obsolete in a changing, transitory marketplace. Studies done by the Education and Work Program of the Northwest Regional Educational Laboratory (NWREL) on the effectiveness of vocational education support these findings: "Areas of greatest dissatisfaction were help in finding a job after program completion and career counseling" (Owens 1980).

Other criticisms regarding vocational education programs include the difficulty many graduates have in self-management and demonstrating analytical and entrepreneurial skills. Employers often find vocationally educated employees are unprepared to participate in decision making, work cooperatively with others as equals, take responsibility for themselves and the quality and quantity of their work, and demonstrate self-initiative and motivation. However, research findings from NWREL clearly show that the majority of vocational education graduates do find employment and satisfaction in jobs related to their technical training. These students, however, are often products of a vocational education program which incorporates general skills into the curriculum. Some vocational education programs are now beginning to combine technical skills with a broad based approach to the development and enhancement of basic skills.

Industrial arts programs have also had their share of criticism in the past. These programs in schools have been designed to "acquaint students with all aspects of industry and technology." But the course content has not changed significantly in 20 years. Industrial arts programs are becoming increasingly more technology education oriented, albeit slowly, by offering courses on transportation and communication systems, housing, power and energy production processes. New programs are being designed to train students to adjust to a changing technological society. The shift appears to be from industrial arts to technology with an emphasis on basic skill development.

The mission statement of the American Industrial Arts Association (AIAA) Board of Directors says that its improvement plan will "provide insight for learners into the evolution, appropriate use, and significance of technology; the organization, system of industry, personnel, techniques, resources and producers of industry; and the social and cultural impacts of both industry and technology" (Foster 1983). According to the plan, by March of 1986, technology education will be piloted in 40 states in this country and abroad; at least 80 percent of the association's 6,000 members will have participated in "professional development activities."

Thomas A. Hughes, associate director for industrial arts for the Virginia State Department of Education, says that industrial arts teachers are now being required to have strong backgrounds in such areas as communications, construction and transportation.

The problem of industrial arts programs is like that of other educational programs that require highly skilled personnel. The shortage of teachers

is severe. A 1981 survey of 45 states revealed that 43 states had critical shortages of math teachers, 33 states had critical shortages of earth science teachers and all states had critical shortages of physics teachers. In addition, half the newly employed teachers for math and science are not qualified to teach those subjects. Fewer than one-third of all U.S. high schools offering physics are taught by qualified personnel. The enrollment is large but industrial arts programs are not high profile courses in education. Like math and science programs, industrial arts programs are experiencing severe teacher shortages. An estimated seven million junior and high school students are now being taught by 55,000 industrial arts instructors. Yet of more than 30 legislative measures introduced in Congress during the past year, none addresses the teacher shortage problems in industrial arts. New incentives for math and science teachers are currently being given attention; however, the same is not true for teachers of industrial arts and other vocational fields.

In summary, there is abundant evidence which indicates a critical need for teachers and curricula that will prepare students for a wide range of roles and responsibilities in the future and not for specific jobs.

At the same time, policy makers and educators must closely examine the increasingly diversified curricula now being offered at most secondary and postsecondary institutions. Attention needs to be given to skill development that will prepare future workers who are flexible enough to effectively handle technological advancements in equipment and conditions.

A combination of specialized training and generalized training seems to be the appropriate approach. Those skills demanded by modern society such as analysis, creativity, communications and organizational and reference abilities should become the firm foundation on which to build specialized skill development. A core curriculum which offers this foundation should be the basis for all elementary and secondary school programs. This type of curriculum, emphasizing basic skill development across all grade and subject areas, will help prepare students to become competent workers and consumers in a high tech world.

According to the Task Force on Education for Economic Growth (1983):

> Not only parents, teachers and students, but all citizens have a stake in how effectively we meet the challenge to improve the quality of education in our public schools. For the quality of our schools will help determine whether our economy in the future grows vigorously or stagnates. And surely all citizens--single people, childless couples and the elderly, as well as families with school-age children--have a stake in our nation's economic health and growth: for these will determine how many jobs are available in the United States, and how adequate our resources will be for vital public services and a decent national standard of living. Because everyone stands to benefit, the consensus for education and economic growth should be truly national.

The Role of Computer Literacy

Not long ago, only a few people worked directly with computers--primarily professional technicians, programmers or computer scientists. This select group required specialized technical training. Most of us only had to be able to read a computer printout to benefit from the information processed via computer. However, as our economy becomes more dependent on information processing, we can expect the majority of future workers to have a direct and significant interaction with computers as a part of daily life. Office work will be heavily dependent on word processing connected with computer based filing; copying and communications systems will dramatically alter office work functions. Information systems will improve an organization's ability to produce and distribute products; managers will interact even more closely with employees whose work requires interaction with the computer system.

Additionally, personal computers will become even more widespread--as a part of home and family life, household management, intellectual and educational development and recreational and creative activities. Personal computers will be used for writing, composing and playing music, for communications and information retrieval.

Computer literacy must therefore be an integral component on any educational system. Computer literacy has been defined as the combined range of skills, knowledges and understandings required to function effectively in an information society. Watt (1980) has divided computer literacy into four interrelated categories:

1) The ability to control and program a computer to achieve a variety of personal, academic and professional goals

2) The ability to use a variety of preprogrammed computer applications in personal, academic and professional contexts

3) The ability to make use of ideas from the cultures surrounding computer programming and computer applications as part of an individual's collection of strategies for information retrieval, communication and problem solving

4) The ability to understand the growing economic, social and psychological impact of computers on individuals and groups within our society and on society as a whole

The Human Resources Research Organization (HumRRO) defines computer literacy and delineates the content areas (HumRRO document 1980):

> Computer literacy may be defined as, "whatever a person needs to know and do with computers in order to function competently in our information-based society." This definition highlights the fact that specific skills, knowledge and values required will vary from person to person, from job to job, and from time to time. Specialized knowledge required for a career as a computer designer, programmer, technician, or analyst is usually excluded

from the computer literacy domain. Content areas often included in "computer literacy" are summarized below.

- Impact of computing on society, my work, my institution
- Applications in various fields
- Programming and problem solving
- Hardware/software/systems
- Awareness of careers
- Personal tool for learning and working
- Control over machines, systems
- Ethical, responsible behavior ⟷ information systems

The need for computer literacy has become obvious; various reasons given for this need include the following (HumRRO document 1980):

- Information-based society: discontinuity in educational needs
- Technological competition: need to increase productivity of U.S.
- Equity of educational opportunity
- Computer an indispensable tool--science, business, government
- Need to take control over machines
- Computers, calculators make some subjects obsolete
- Need to learn tools for dealing with complex phenomena
- Most careers are computer related

Education for computer literacy must therefore, out of necessity, involve many years of hands-on experience with computers as well as establishing personal concerns and values related to the use of computers and their effect on society. A computer literate culture means parents, teachers, students and others becoming increasingly more skilled and knowledgeable from generation to generation. A high priority for schools, then, should be the growth of computer literacy among teachers and the increasing incorporation of computers into all grade and subject areas.

A recent conference on computer literacy supported by the National Science Foundation attempted to identify issues, considerations and barriers to developing a national goal for achieving a computer literate society in the United States. The conference found the following are key components for achieving computer literacy (Seidel et al. 1982):

1) There is a need to recognize that the concept of computer literacy is multifaceted. A diversity of opinion exists as to what constitutes computer literacy and all ideas should be welcome.

2) There is a need to identify and develop a significant number of knowledgeable people both to create new tools and materials and to effectively use them. People are the most important resource--teachers, faculty, board members, parents and administrators are all potential users of the new technologies and play a key role in preparing students for the future.

3) There must be involvement by the home, the workplace and the community as well as the school to create a computer literate

society. Television, libraries, amusement centers, retraining and continuing education programs in business and industry must work with the home and school to help make young people more familiar with computers.

4) There must be computers available for instruction in all schools and for all students. A computer should be in every classroom from kindergarten through the eighth grade; in grades 8 through 12, computers should be available in a laboratory environment for every student; in higher education, an achievable goal is to require every student to have his or her own personal computer.

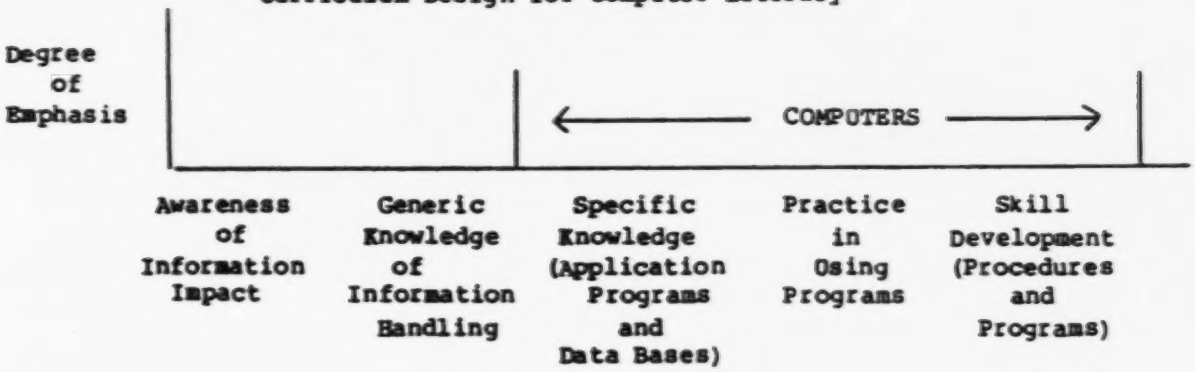
5) There is a critical need for high-quality curricula and courseware. A comprehensive curriculum and critical mass of high-quality courseware are needed in mathematics, science and social science. A nationally organized effort, including support from business, industry, state and local governments as well as the federal government is needed to reach this goal.

6) There is a need for continued innovation, research and development to identify new opportunities for the use of computers. Of special concern is fundamental research on such areas as human cognition, person/machine interaction and ethics and values.

One proposed curriculum design for computer literacy puts the emphasis on need and interest (Seidel et al. 1982). This design has potential for use by a variety of groups--workers, home consumers and students. Three basic areas are included in this information handling curriculum: 1) awareness of information impact, 2) generic knowledge of information handling and 3) the specific knowledges and skills related to the use of computers. Following is one proposed continuum of an information handling curriculum.

TABLE 6

Curriculum Design for Computer Literacy


Degree of Emphasis
COMPUTERS
Awareness of Information Impact
Generic Knowledge of Information Handling
Specific Knowledge (Application Programs and Data Bases)
Practice in Using Programs
Skill Development (Procedures and Programs)

Source: Computer Literacy, edited by Robert J. Seidel et al., 1982.

The National Commission on Excellence in Education recommends compulsory instruction in what it calls the "new basics:" four years of English, three years of math, science and social studies, and a half-year of computer science for all students. Many schools are responding to the challenge and addressing the need for computer literacy. Schools are stiffening academic requirements in response to current national reports criticizing American education. Students in many schools are now taking more math, science, English and foreign language courses in addition to learning more about computers, taking more tests and doing more homework. For example, the New York State Board of Regents passed an "Action Plan" that has students taking more academic courses, fine arts courses and computer education as well as doing more homework and spending more time in school. In Minnesota, two percent of the nation's school children have access to six percent of the nation's school computers. The state is further supporting its technological head start with students by adding 20 new computer training centers for teachers and allocating extra funds for districts to integrate computers into the curriculum. Next year, Houston Public Schools will add computer literacy to the state's graduation requirements, backing up the move with software libraries in each school and a department of technology to train teachers. Huntington Beach, California, has instituted achievement exams in economics, history, government and computer literacy in addition to the math and English tests mandated by the state. To graduate, students must pass all tests. The Tri-County Task Force in Multnomah County, Oregon (1979) has developed a list of over 400 course goals in computer education for grades K-12.

Clearly, schools and school districts around the country are trying a variety of approaches to help students become more computer literate. These approaches center on teacher training, curriculum development and acquisition of equipment. They emphasize computer literacy in one or more subject areas.

Some of these efforts have been more successful than others as measured by the number of students and teachers reached, the outcomes attained and the stability of the programs. Many approaches lack systematic integration of computer literacy learning outcomes into the existing curriculum. In addition, schools are facing an overwhelming array of pressures to reform. Minimal competencies, back-to-the-basics, energy conservation, equity, career awareness and lifelong learning skills are but a few of the challenges schools face for instructional change. Computer literacy, to be effective, must integrate its outcomes with other instructional areas, goals and priorities.

IV. HOW EMERGING TECHNOLOGICAL CHANGES AFFECT JOBS IN NORTHWEST INDUSTRIES--SUMMARY OF INTERVIEWS

Introduction

Following is a summary of ideas and perceptions given by employers in three major industries: Wood/Forest Products, Health Services and High Technology.

These representative industries were identified as those most likely to employ substantial numbers of people into the 1990s.

Each has been affected, to various degrees, by the changes in technology in recent years. Those effects will be discussed as they relate to the interview instrument.

Approach

Personnel were interviewed from three different employment levels within each industry: staff, supervisory and executive. Interviews were conducted on-site during a two-week period in July, 1983. The instrument used was designed as a brief, general survey of interest. It was designed to accommodate the wide range of responses anticipated from the selected industries.

Contact persons at each site were identified and called upon to assist in the gathering of the data. They helped locate employees at different levels of employment within a given company and sometimes participated in the interviews as well. Persons identified for interviews included those most easily available and those most knowledgeable about the subject matter. A sufficient range of employment levels throughout each industry was reached to provide a broad view of technological changes, requirements and outlook for the future.

Each 20- to 35-minute interview concluded with the interviewee given the opportunity for open response to the topic of technology's impact on education.

Common Responses Across all Industries

As might be predicted, all industries interviewed have been affected by the advent of new and emerging technology--some industries more than others and some occupations more than others, even within the same company.

It is also worth noting those areas that have been least affected by the new technology. For example, in offices where information is processed, stored or retrieved, computers have assumed a critical new role. On the other hand, executives who are influenced by this information have quite limited interaction with the computer itself.

The most common major change in the workplace is the addition of computers and attendant "industry appropriate" technology. This has directly affected the expansion of information systems and the capability of interfacing data processing and word processing. Across industries, electronic mail, equipment miniaturization and computer networking are gaining utility and momentum.

One example of technological change peculiar to the health care industry is the evolution of an entirely new field called endoscopy. This new process combines fiber optic technology with internal medicine enabling a hair-thin fiber to be channeled through the digestive canal. Once in the colon, membrane tissue can be examined extensively for damage, rupture, irritation and so on. Previously, this procedure could only be done through surgery. Soon, camera technology will provide a means of securing still and video images with considerably more detail than current X-ray technology. Ultimately, laser technology will add to this procedure the capability of performing surgery without incision.

A more general effect of the "micronization" in new technology is the actual reduction in physical dimensions of equipment. This is particularly important in health care where patients can now carry what used to be impossibly cumbersome equipment with a shoulder strap. Portable respiration and dialysis equipment as a result of microprocessor technology also signify the quality of change potential.

In high technology industries, again as a result of "everything getting smaller and lighter" according to one high tech design engineer, there is much less need for the manufacturing of "chassis" to house and support the once cumbersome equipment.

One less obtrusive but equally dynamic change in the workplace, and soon to be more common, is improved automation in telephone systems. Telephone lines are already essential to the concept of telecommunications. Electronic mail and teleconferencing are but two of the more common manifestations of the new "telephone technology." Computer driven telephone switching systems have ushered in a myriad of options with pushbutton equipment, and it is anticipated that shopping, banking and interactive television will be tied to the telephone in the near future.

Among the more visible effects of computer technology in the workplace and another trend for the future is fewer "paper dependent" offices which should result in less waste and greater efficiency.

Increased availability of new technology coupled with suitable applications are cited most commonly as the driving force behind the changes. Most of the persons interviewed agreed that the additions of new technology were tied to an effort to improve efficiency at reduced cost. Each industry, whether service or product, desires to affect the proverbial "bottom line."

Attitudes/Skills/Competencies Needed for Employability and Promotion

While computer skills would be expected to head the list of competencies identified by employers for future workers, mentioned more frequently were communication skills, interpersonal skills and the foundation of a solid but broad fundamental education.

Adaptability is becoming increasingly more important. "Things have changed so much and so rapidly," says one personnel manager, "that one thing we have to be sensitive about is the willingness of a person to accept change in the environment." Actually, some people are only comfortable if they can get a job and expect to do the same thing for years. It just isn't that way anymore," he adds.

Similarly, a person who comes to new employment with the ability to perform more than one task is considered to be more valuable than the worker with a limited skill range. Being "flexible" was a term used by all industries as a desirable attribute because of the potentially changeable work environment. This generally meant the ability to handle more than one task at a time.

Performing multiple functions occurs in certain jobs at present, but according to employers, advancing computer capabilities will make this ability even more important in the future. For example, in a sawmill where a crew of laborers previously "eyeballed" lumber for thickness, quality of cut, moisture content and such, an individual now electronically monitors various phases of "process" and "quality" from a computerized control room.

In a hospital administration office, where data on patients were formerly drawn from several different sources, complete data are now presented on a screen in a fraction of the time. This changes the nature and logistics of work. In both examples, only information is moving; the job is done without the individual having to move.

Employees can be "taught" to perform tasks similar to these. However, the critical reading skills required to guide a person through a computer operator's manual in the event of an error and which enable a person to work independently cannot be taught at that stage of employment. Thus, employers are more concerned with reading ability and thinking skills of new employees than with their technical skills.

"Openness to learning" is a desirable attitude. When asked about preferred attitudes for new workers, employers responded with a very traditional set of work ethics including honesty, industry, loyalty and so on. In terms of the impact of technology on those characteristics, the list is augmented with flexibility, enjoying interaction with others, independence and initiative, tolerance, patience and attention to detail.

A positive if not a polished self-image and the ability to relate to others is the "ideal" disposition sought by employers. Although it stands to reason that a positive attitude lends itself to successful job performance, it is worth mentioning that 90 percent of those interviewed

made reference to its importance. In critically competitive economic times, the sales division of wood/forest products and high technology industries in addition to the nursing field are paying particular attention to "positive attitudes."

It appears inescapable that the workplace will continue to become more "precision intensive." A foundation of solid communication skills (reading, writing, listening, speaking and reasoning) coupled with enhanced math preparation is going to be essential. Employability and promotion will be somewhat related to computer or technical background.

"Teamwork potential" also seems to be taking on added importance in selection criteria for new employees. Common to these three industries is the recognition of "change" as a staple in the management and productivity of a company. One employer put it this way, "We are looking for people who not only can cope with a changing environment, but also are invigorated by the potential of change."

The combination of attitudes and skills for tomorrow's employees is characterized by "flexibility" and "breadth" rather than categorical specialization. At the staff level, being changeable or perhaps, interchangeable and adaptive will be requisite skills. At the supervisory level, superior communication skills, especially listening, and interpersonal skills head the list of competencies. At the executive level, where the impact of new technology seems to be more indirect, being adaptive and acquiring an appreciation for the new technologies will be advantageous in improving the way things are done and in industrial competition.

As one health care executive remarked, "We have made it a matter of policy to accept the use of computers as a way of doing business."

There is heightened expectation from all levels for a solid liberal arts education accompanied by some knowledge or expertise in computers and industry-appropriate technology.

Implications for Schools

As part of the survey, employers were asked to respond to the question, "What should the schools be doing?"

Although the interview instrument was primarily directed toward the role of the high school and the community college, several respondents mentioned the middle school or junior high school as the place to begin shaping and preparing young people for the "information age."

The survey consistently revealed that schools need to re-emphasize basic reading and math skills. However, several interpretations can be made regarding this response. For example, a "back-to-the-basics" approach will not remedy the situation of ill-equipped young people soon to enter the job market and is not what is meant when respondents suggest a "back-to-the-basics" approach.

Though schools need to emphasize reading, math and communication skills, especially listening, interviewees also frequently mentioned "development of the mind." When explored, it was found that "basics" are not as underdeveloped as are reasoning skills, critical thinking skills, study habits, memory skills, the ability to concentrate, understanding the nature and reality of work and employment and a solid work ethic.

Respondents consistently said they would like to see more "math and science emphasis" and "applied use" of basic skills in the public schools.

An emphasis on problem solving was mentioned as one way schools can better help students acquire the basics.

Especially interesting were the responses interviewees gave when asked why they wanted "science" to be emphasized. The responses centered around the idea that science courses were more rigorous. While that may be a fair impression of science courses in many schools, all do not have the rigor of a physics class, nor is "rigorous" study limited to that discipline.

Regarding math, the responses seened to equate "structure and discipline" with "mathematics." Also mentioned were foreign languages and statistics as a way to provide the structure and discipline that would fortify our young people.

It is important to note that on closer examination, when some respondents mentioned increased emphasis on math and science, they often meant "more rigor, more structure and more intensive study" as the responsibilities of the public schools.

Interviewees consistently suggested that "exposure" to the work site might make learning more meaningful for teachers and students and might affect teachers' perceptions about the appropriateness of the curriculum. Greater emphasis on career education might also lead to the desired outcome of better prepared students.

For community colleges, communication skills were seen as an important part of the curriculum. Industry executives say they need "versatile" people. New employees who can write and speak effectively as well as perform their technical tasks are considered more valuable than those employees having only the technical skills.

It was also suggested that because some community college or junior college graduates are likely to be placed in a supervisory role, interpersonal and supervisory principles should be a part of those curricula.

Interviewees unanimously stated that orientation to computer skills will continue to be important. Basic reading, math and computer skills brought from high school into community college programs should be reinforced and strengthened.

It was felt that community colleges should examine the possibility of expanding their programs to include three or four years of study.

Nearly all companies find it efficient and cost effective to retrain employees either on-site or through a reimbursement program at the local university. Most common was on-the-job training utilizing seasoned employees.

Open Response

Common responses in this part of the interview were few but worth identifying:

1) Regarding the impact of technology on public education, respondents were quick to point to the need for educators and school districts to monitor and re-evaluate change. They felt that the rapidity, intensity and implications of change for education is something which should not be left to chance.

2) Helping young people understand the concept of "adult responsibility," i.e., what will be expected of them as adults and employees, needs critical attention. However, while respondents were suggesting more structure, more in-class time and less frills, they were also suggesting that students be given a more realistic view of the world through experiential learning activities, including internships, shadowing, practicums and field trips tied to the classroom activities.

3) "Decision making skills" were mentioned several times as legitimate educational objectives. Decision making skills were seen as a lifelong learning need that would help young people to survive the anticipated competition for limited good paying jobs in the 1990s.

V. POLICY RECOMMENDATIONS

It is essential that policy makers closely inspect and address the magnitude of the issues presented in this paper. The future of our economic stability and social well-being lies in the ability of schools to adequately prepare young people for a growing, changing technological society. Especially important is the need to improve mathematical, scientific and technological literacy as a part of a general curriculum. Based on the interview data and the literature review, recommendations for policy makers and educators to consider are made in the following areas: (1) Purposes and Goals, (2) Personnel, (3) Management, (4) Curriculum, (5) Resources and (6) Implementation.

1) Purposes and Goals

To promote higher standards of educational achievement, it is necessary for schools to more clearly define their purpose and goals as they relate to a technological future. Examples of goal statements that reflect expanded mathematical, scientific, computer and technological literacy include:

- The need for all students to be mathematically and scientifically literate in order to participate in our technological society.
- The need to respond to the rapidly increasing availability and importance of computers in business, industry and the home.
- The recognition of the vocational preparation needs of all students, including gifted students, as well as vocational requirements for middle-range skilled positions.

Policy makers and educators need to consider the following in developing their own goals that address technological literacy:

- Increase awareness of the contribution of human resources to economic productivity.
- Increase understanding of the diverse needs of today's students and tomorrow's workers.
- Improve partnerships in education and industry; business and labor leaders as well as other professionals need to become more involved in education.
- Make goals in education relevant to technological advancements; improving mathematical, scientific and technological literacy should be attributed top priority for action and put in the context of achieving excellence in education.
- Improve linkages between communities and schools.

2) Personnel

To assure schools have qualified personnel in math, science and technical components of education, policy makers need to consider the following:

- Actively recruit and increase the numbers of qualified teachers in math, science and other technical areas; prepare teachers for interdisciplinary training and approaches.

- Increase salaries for qualified teachers of math, science and related technical areas to be professionally competitive.

- Employ nonschool personnel to help solve the problem of teacher shortages in math, science, vocational education and industrial arts; develop a working relationship with business to provide training seminars, workshops, open houses, hands-on training.

- Develop and implement new and viable reward systems for honoring excellence in the teaching of math, science and technical components of education.

- Encourage young people interested in math and science to consider a teaching career in these fields; especially encourage women and minorities to enter these fields.

- Provide ongoing teacher inservice to update teacher understanding of technological literacy.

3) Management

To assist schools in expanding and improving their use of effective management techniques at every level of administration, policy makers need to consider the following:

- Principals and superintendents must play a critical role in garnering support for instructional improvement programs; school boards must provide principals and superintendents with the resources and support necessary to help them carry out their leadership roles.

- In addition to school board members, state and local officials including governors and legislators must take responsibility for helping schools achieve goals in instructional improvement for technological competence.

- The federal government must help states achieve goals in educational improvement for technological literacy; this assistance can take the form of supporting curriculum improvement and research on technological literacy, supporting teacher training and providing financial assistance for research and graduate training.

- Principals must take the lead in developing and implementing programs in technological literacy.

- Administrators must take responsibility for developing and implementing comprehensive preservice and inservice programs for teachers to assist them in becoming competent in skills required for technological literacy.

- The management of curriculum, classrooms and facilities must be improved to increase student achievement in technological literacy.

4) Curriculum

To improve the academic experience for students in technological literacy, policy makers and educators need to consider the following:

- Attribute top priority to the improvement of mathematical, scientific, and computer literacy in schools; revise curriculum to reflect this priority.

- Introduce technological literacy into the curriculum at the elementary level and continue throughout high school and postsecondary institutions.

- Develop comprehensive programs in technological literacy across all grade and subject areas including computer applications; include technological issues in the study of history, government, physical education and other curricular areas.

- Revise curricula to reflect changing technological advancements.

- Increase time-on-task for math, science and technological literacy programs in schools.

- Restructure secondary schools to strengthen the basic curriculum while concurrently providing for the availability of technical courses.

- Increase curricular requirements for instruction in higher order skills, including problem solving, synthesis, analysis and evaluation; use computer applications to help develop critical thinking and problem solving skills.

- Administer periodic tests for achievement in technological literacy to students; student promotion should be tied to successful performance on achievement tests.

- Seriously address the relationship between liberal arts and technological literacy.

5) Resources

To effectively enrich academic programs in technological literacy, educators and policy makers need to consider the following allocation of resources:

- Increase state-of-the-art resources and equipment for math and science teachers and students.
- Place computer terminals in all classrooms.
- Develop computer based tools and softwares that allow students to use the computer in ways that are real and meaningful to them--for example, simple word processing systems and data handling tools.
- Secure funding for scholarships in math, science, computer programs.
- Provide funds for specialists to work with districts and teachers in improving programs in math, science and technological literacy.
- Secure funds to provide summer employment for math and science instructors.
- Involve business and industry in providing necessary equipment (computers, other hardware and software).

6) Implementation

To work toward achieving the goal of excellence in education and providing quality instruction in computer and technological literacy, the following activities that have potential for implementation should be considered by educators and policy makers:

- Develop informational materials on the status of math and science literacy in schools and implications of these findings for economic productivity; disseminate to the public, boards of education, legislators and community people.
- Assist the public in their understanding of technological literacy by providing workshops and materials on how the public can best support the work of their schools and their young people.
- Provide informational materials to the media; work with these persons to report on the needs, problems and solutions schools face in achieving competence in technology education.
- Develop lists of human resources from which various community groups can draw speakers and consultants who are available to work with groups to increase awareness and develop programs for action.

- Use professional education and business groups as sounding boards for discussion of issues, evaluating materials and providing feedback on proposed action plans.

- Secure financial resources to guarantee all students have access to computers and other technology equipment at all grade levels.

- Strengthen high school graduation requirements to include greater emphasis on science and math competencies.

- Initiate state mandates for programs in technological literacy including computer education.

- Examine college entrance requirements for math and science competence; consider possibilities of raising these standards and using vocational/technical education courses as vehicles for instruction in applied math and science.

- Consider the establishment of magnet programs in math, science and technological literacy for gifted students.

- Consider the establishment of technological literacy fairs, including demonstration and application of math, science and computer concepts.

- Encourage the participation of female and minority students in math and science programs.

- Initiate comprehensive teacher inservice programs for math, science and computer concepts.

- Secure relationships with private science laboratories, businesses, museums, computer organizations and other institutions.

- Develop new and viable reward systems for honoring and publicizing excellence in math and science achievement.

- Develop funding sources for math and science facilities, equipment, materials and teacher training.

BIBLIOGRAPHY

Action for Excellence. Task Force on Education for Economic Growth, Education Commision of the States, June 1983, 50 pp.

"America Rushes to High Tech for Growth." Business Week. March 18, 1983, pp. 84-90.

A Nation at Risk: The Imperative for Educational Reform. A Report to the Nation and the Secretary of Education, National Commission on Excellence in Education. Washington, D.C., April 1983, 65 pp.

Automation and the Workplace, Selected Labor, Education and Training Issues. Office of Technology Assessment. Washington, D.C., March 1983, 105 pp.

Bottoms, Gene. "It's Not Just Math and Science." Professional Perspective. AVA/Update. March, April 1983, p. 8.

Challenge of the 80's, A Report of 80's Technology. An Industry-Education Symposium. December 6, 1982, Vancouver, WA, 26 pp.

Clayton, Gary E. Worker Productivity--A Challenge for Voc Ed, National Center for Research in Vocational Education, Information Series No. 235. The Ohio State University, Columbus, Ohio, January, 1982, 30 pp.

DeBevoise, Wynn. The Contribution of Education to Productivity: Schooling in a Technological Society. March 1983. Available from Editor-Clearinghouse on Educational Management, College of Education, University of Oregon, Eugene, OR 97403.

"Demand for Electronics Technicians to Jump 60 Percent." Education Daily. August 16, 1983, p. 6.

Developing High Technology Vocational Programs. Resource Guide. Presented by the American Vocational Association (AVA) and the Center for Occupational Research and Development (CORD) at the AVA/CORD Regional Workshop. May 1983, 174 pp.

Dunn, John. "Those High-Pay Computer Jobs Few, Far Between." The Oregonian. August 11, 1983, p. A20.

"Education and Technology: Predicting the Needs of the Future." Perspectives. R&D Center for Educational Policy and Management, University of Oregon, Fall 1982, 8 pp.

Education for a High Technology Economy. Materials Prepared for Governor's Special Briefings, Education Commission of the States. August 1982, 30 pp.

Employers and Young Adults Look at Vocational Education. Ohio Advisory Council for Vocational Education. Columbus, Ohio, 1973, 54 pp.

Paddis, Constance, et al. Preparing for High Technology: Strategies for Change. The National Center for Research in Vocational Education, The Ohio State University. Columbus, Ohio, 1983, 43 pp.

Feingold, S. Norman and Norma Reno Miller. Emerging Careers: New Occupations for the Year 2000 and Beyond. Garrett Park Press, Garrett Park, Maryland, 1983, 172 pp.

Foster, Susan G. "Industrial-Arts Group Urges Emphasis on 'Technology Education.'" Education Week. April 1983, p. 8.

Goldhirsh, B. A. High Technology. Vol. 1, No. 1, 1981.

Harris, Philip R. "Future Technological Work Culture: Part I," Leadership and Organization Development Journal. 1983, pp. 7-12.

Hart, Gary. "Investing in People for the Information Age." The Futurist. February 1983, pp. 10-14.

"High Technology is a Fact of Life at Community Colleges." Education Daily. May 5, 1983, p. 6.

Huddleston, Kenneth F. If Productivity is the Problem.... Special Publication Series No. 36, The National Center for Research in Vocational Education, The Ohio State University. Columbus, Ohio, June 1982, 48 pp.

Hull, Daniel M. and Leno S. Pedrotti. "Meeting the High-Tech Challenge." Voc Ed. May 1983, pp. 28-31.

"Human Creativity Remains a Prime Factor in High-Tech Jobs." St. Petersburg Times. June 19, 1983, p. 3F.

Hunt, H. Allan and Timothy L. Hunt. Human Resource Implications of Robotics. W.E. Upjohn Institute for Employment Research. 1983, 207 pp.

Hunter, Beverly. An Approach to Integrating Computer Literacy into the K-8 Curriculum. HumRRO Professional Paper 2-80, October 1980.

Information Technology and Its Impact on American Education. Office of Technology Assessment. Washington, D.C., 1982, 259 pp.

Jones, Ronald E., Donald P. Lauda and John R. Wright. Work and Education in the Eighties. Monograph 9, American Council on Industrial Arts Teacher Education. 1982-1983, 26 pp.

Kandel, Thelma. "What People Earn." Parade. July 10, 1983, pp. 4-6.

Levin, Henry and Russell W. Rumberger. The Educational Implications of High Technology. Institute for Research on Educational Finance and Governance, School of Education, Stanford University. February 1983, 16 pp.

Lofquist, William A. "How Do 'Megatrends' Affect Youth Opportunities and Their Design?" New Designs for Yough Development. A National Publication of Associates for Youth Development, Inc. March-April 1983, p. 27.

New Technologies: Their Impact on Employment and the Working Environment. International Labour Office. Geneva, 1982, 174 pp.

Perrow, Charles. "A Framework for the Comparative Analysis of Organizations." American Sociological Review. 1967, pp. 194-208.

Riche, Richard W. "Impact of New Electronic Technology." Monthly Labor Review: Employment in 1981. Vol. 105, No. 3, March 1982, pp. 37-39.

Schon, D.A. Technology and Change. Delacorte Press, New York, 1967.

Seidel, Robert J., Ronald E. Anderson and Beverly Hunter (eds.). Computer Literacy. New York: Academic Press, 1982.

"The Computer Moves In." Time. January 3, 1983, pp. 14-24.

The Information Society: Are High School Graduates Ready? Education Commission of the States. September 1982, 65 pp.

The Process of Technological Innovation: Reviewing the Literature. Productivity Improvement Research Section, Division of Industrial Science and Technological Innovation, National Science Foundation, May 1983, 245 pp.

"The Speedup in Automation." Business Week. August 1981, pp. 58-67.

"The Trouble with Kids." INC. January 1983, pp. 57-62.

"Training Must Change as Use of Robots Grows, Experts Agree." Education Daily. May 26, 1983, pp. 5-6.

White, Stephen. "The New Liberal Arts." An Occasional Paper from the Alfred P. Sloan Foundation, edited by James D. Koerner, New York: Alfred P. Sloan Foundation, 1981, p. 77.

"Work Attitudes Survey: How Youth View and Value Work." Greater Portland Work-Education Council. September 1981, 79 pp.

APPENDICES

Appendix A: Basic Skills and Competencies for Productive Employment

Appendix B: Data Summary of Employer Interviews--Wood/Forest Products

Appendix C: Data Summary of Employer Interviews--Health/Hospital Services

Appendix D: Data Summary of Employer Interviews--High Technology

APPENDIX A: BASIC SKILLS AND COMPETENCIES FOR PRODUCTIVE EMPLOYMENT

SOURCE: Action for Excellence, Task Force on Education for Economic Growth

Following is a list of skills developed by business representatives on the Task Force as those necessary for young people to master if they are to achieve success in the workplace. The Task Force, in developing the list, drew heavily upon the work done by the Center for Public Resources and Project Equality of the College Board.

Reading Competencies

- The ability to identify and comprehend the main and subordinate ideas in one's own words
- The ability to recognize different purposes and methods of writing, to identify a writer's point of view and tone, and to interpret a writer's meaning inferentially as well as literally
- The ability to vary one's reading speed and method and one's purpose for reading according to the type of material
- The ability to use the features of printed materials, such as a table of contents, preface, introduction, titles and subtitles, index, glossary, appendix, bibliography
- The ability to define unfamiliar words by decoding, using contextual clues, or using a dictionary

Writing Competencies

- The ability to organize, select and create ideas and to outline and develop them in coherent paragraphs
- The ability to write standard English sentences with correct sentence structure, verb forms, punctuation, capitalization, possessives, plural forms, other matters of mechanics, word choice and spelling
- The ability to improve one's own writing by restructuring, correcting errors and rewriting
- The ability to gather information from primary and secondary sources, to write a report using this research; to quote, paraphrase, and summarize accurately; and to cite sources properly

Speaking and Listening Competencies

- The ability to engage critically and constructively in the exchange of ideas
- The ability to answer and ask questions coherently and concisely, and to follow spoken instructions
- The ability to conceive and develop ideas about a topic for purpose of speaking to a group; to choose and organize related ideas; to present them clearly in standard English

Scientific Competencies

- The ability to understand the basic principles of mechanics, physics and chemistry
- The ability to distinguish problems whose genesis is in basic mechanics, physics or chemistry

Reasoning Competencies

- The ability to identify and formulate problems, as well as the ability to propose and evaluate ways to solve them
- The ability to recognize and use inductive and deductive reasoning, and to recognize fallacies in reasoning
- The ability to draw reasonable conclusions from information found in various sources, whether written, spoken, tabular or graphic, and to defend one's conclusions rationally
- The ability to apply basic scientific/technical solutions to appropriate problems

Mathematical Competencies

- The ability to perform the computations of addition, subtraction, multiplication and division using natural numbers, fractions, decimals and integers
- The ability to make and use measurements in both traditional and metric units
- The ability to use effectively the mathematics of integers, fractions and decimals, ratios, proportions and percentages, roots and powers, algebra and geometry
- The ability to make estimates and approximations, and to judge the reasonableness of a result
- The ability to use elementary concepts of probability and statistics

In addition to the above competencies identified by the Center for Public Resources, the following competencies were also felt to be important:

Basic Employment

- The ability and willingness to assume the responsibility of a good citizen
- The ability to engage in interpersonal relationships
- The ability to cope with requirements concerning attendance and punctuality

Economic Competencies

- The ability to understand personal economics and its relationship to skills required for employment and promotability
- The ability to understand our basic economic system (e.g., profits, revenues, the basic law of supply and demand, etc.)

Computer Literacy Competencies

- The ability to follow predefined procedures and to understand when the procedure is completed successfully and when it is not
- The ability to operate equipment that requires understanding of a predefined procedure, to know when operator action is required
- The ability to understand the basic functions of a computer device (terminal, CRT, etc.)

APPENDIX B: DATA SUMMARY OF EMPLOYER INTERVIEWS-- WOOD/FOREST PRODUCTS

1. JOB TITLES

Personnel manager
Office services supervisor
Teletype operator
Sales representative
Professional employment manager
Personnel director
Personnel services director
Employee relations representative

2. WHAT MAJOR TECHNOLOGICAL CHANGES HAVE YOU SEEN IN YOUR COMPANY IN THE PAST FEW YEARS?

Expanded use of data processing
Addition of CRT
Electronic mail
Correcting typewriter
Interaction between wp and dp equipment
Greater access to technology
More user friendly equipment

2a. CAUSES?

Greater technological capability
Efforts to reduce costs
Improved grades of steel for saw blades

3. WHAT EFFECTS HAVE THESE CHANGES HAD ON: (A) NUMBER OF NEW EMPLOYEES HIRED, (B) TYPE OF WORK COMPETENCIES NEEDED, (C) TYPE OF FUTURE TRAINING?

3A. Negligible

3B. Keyboard skills (2)
Ten key skills
Above average reading/math skills (3)
Analytical skills
Multitask ability
Interpersonal skills

3C. Computer training (3)
Keyboard (3)
Understanding forest products/lumber industry
Automated office equipment
Languages for programming

4. WHAT PARTICULAR OCCUPATIONS OR JOBS WITHIN YOUR COMPANY HAVE BEEN MOST AFFECTED BY TECHNOLOGICAL CHANGES?

Sawyer at the mill
Filer at the mill
Packing at the mill
Finance, clerical, technicians, engineering, process and quality control

5. WHAT ARE SOME NEW TECHNOLOGICAL CHANGES THAT ARE LIKELY TO IMPACT YOUR FIELD IN THE NEXT FIVE YEARS?

New glues
Improved blades for sawing
Less waste
Electronic scanners
Desktop computers for decision makers
Automated telephones
Less paper-dependent office work
Networking of micros within company

6. ARE THERE CERTAIN ATTITUDES THAT YOU FEEL ARE IMPORTANT FOR NEW EMPLOYEES TO BRING INTO THE COMPANY?

Specific personal goals (2)
Good self-concept (3)
Good grooming
Teamwork (3)
Flexibility (5)
Enthusiasm (2)
Initiative (2)
Willingness to learn new things (5)
Accuracy
Industriousness
Coping with change (3)
Good character
Adaptability
Loyalty to company

7. WHAT SKILLS ARE CONSIDERED IN HIRING AND PROMOTIONS?

Listening skills (3)
Ability to learn quickly
Math and reading skills
Interpersonal skills (4)
Quantitative/analytical skills
Computer background
Telephone skills organization
Attention to detail
Keyboard skills
Problem solving skills
Advanced writing skills (i.e., being able to translate ideas to paper) (3)
Ability to speak (meetings)

8. WHAT ROLE DO YOU FEEL THAT HIGH SCHOOLS SHOULD PLAY IN HELPING TO PREPARE YOUNG PEOPLE FOR EMPLOYMENT IN A COMPANY LIKE YOURS?

Computer literacy (3)
More than minimum math skills
Business/technical skills
Word processing (3)
Counseling that keeps students aware of skills employers are asking for in the job market
Greater exposure to technology
Balancing technical education with emphasis on basic skills
Teach thinking/reasoning skills
Reduce drug use
Syntax emphasis (writing skills)
Encourage standard dress codes which match prospective employer's expectations
Strong basic education
Fewer elective courses
Teach about the information age
Spend more time educating young people about work instead of pushing them into the labor market with inadequate preparation

9. WHAT ROLE TO YOU FEEL THAT COMMUNITY COLLEGE/VOCATIONAL PROGRAMS SHOULD PLAY IN TRAINING?

Courses in flexible packaging and other forest products
Offer technician apprenticeships or practicums
Offer courses in wp, dp, computer repair
Train people in the "how to" of supervision because many good workers get promoted to a supervisory capacity and have no idea how to do as well as they did in their former job
"Tune into" business/employer expectations
Create a better match between curriculum and reality
Reasoning skills
Match training with job market

10. WHAT ROLE DOES/SHOULD YOUR OWN COMPANY PLAY IN TRAINING AND UPGRADING EMPLOYEE SKILLS?

OJT (5)
Education/$ reimbursement (3)
In-house courses in personal development
Train people in more than one job
Company trains all new employees
Company does train when shifts in roles of employees occur
Does provide training or $ for supervisory courses
Company expects people to move
Use experienced personnel on job to train

11. **DO YOU HAVE ANY OTHER THOUGHTS ON THE EFFECTS THAT TECHNOLOGICAL CHANGE MIGHT HAVE ON PUBLIC EDUCATION?**

As change occurs we need to better anticipate the effects on the hourly wage employee.
Productivity can go up with fewer employees.
Schools need to prepare for more realistic assessment of what is taking place in the job market. We need to try more experiential learning.
We need to not lose sight of world affairs in the rush to become technology oriented. Balance overemphasis on technology with lifelong learning skills.
Be more aware of the rapidity of change today.
Word processing is replacing secretaries.
Increased need for solid math education.
Completed degree will become more standard for entry level positions.

APPENDIX C: DATA SUMMARY OF EMPLOYER INTERVIEWS--HEALTH/HOSPITAL SERVICES

1. JOB TITLES

Associate regional
Director ambulatory services (2)
Supervisor endoscopy services
Housekeeping staff
Assistant coordinator surgical services
Chief p.a.--surgery
Director--human resources
Director--marketing/enrollment

2. WHAT MAJOR TECHNOLOGICAL CHANGES HAVE YOU SEEN IN YOUR COMPANY IN THE PAST FEW YEARS?

Computers: electronic mail, wp, dp, file storage
Information management
Office automation: wp, trend analysis, operational demographics, fiscal management
Availability of technology
New cleaning chemicals
Monitors for fetal heart tones
Ultra sound scans
Imed pump: computarized measure of i.v. intake
Surgery: electronically controlled anesthesia, blood pressure, heart rate, pulse and respiration
Disposable endotracheal tubes
Disposable surgery drapes
Electronically monitored air filtration system in surgery
Automated cashiering in food services
Microcomputer system as adjunct to larger computer system
Radiology: ct scan, computerized tomography, nuclear magnetic resonance
Surgery: laser technology, prosthetic device implants
Fiber optic technology
Expanded and more accessible data system
Shorter stays for tonsillectomy
More detailed medical diagnosis
Reduced radioactive exposure risk

2a. CAUSES?

Efficiency of technological devices
Better assurance of post operative success
Cost-effective potential
Evolution of appropriate technology
More demanding and complex regulations
Greater need for information

3. WHAT EFFECTS HAVE THESE CHANGES HAD ON: (A) NUMBER OF NEW EMPLOYEES HIRED, (B) TYPE OF WORK COMPETENCIES NEEDED, (C) TYPE OF FUTURE TRAINING?

3A. Variable; not significant

3B. Slight increase in technically-oriented nurses
"Critical situation" nursing background
Thoroughness; attention to detail
Adjustment to new and changing equipment
More precise reading skills
Instrumentation; anticipation/reading of situation; make decision/implement decision
More specialization in each operating room technology
Willingness to change with trends

3C. More specialized training in modern equipment

4. WHAT PARTICULAR OCCUPATIONS OR JOBS WITHIN YOUR COMPANY HAVE BEEN MOST AFFECTED BY TECHNOLOGICAL CHANGES?

All aspects of patient care modes
Specific areas: nursing, therapy, central supply, i.v. therapy
Nursing (4); medical records; information services
Secretaries; physicians; gastrointestinal operations; pulmonology
Accounting; billing
Decision makers at policy level: use of computers as a way of doing business

5. WHAT ARE SOME NEW TECHNOLOGICAL CHANGES THAT ARE LIKELY TO IMPACT YOUR FIELD IN THE NEXT FIVE YEARS?

Computerized appointment schedule
Televideo conferencing
Electronic mail
Communication systems: telephone, information management
Flexible instruments replacing rigid instruments in internal medicine
Laser technology combined with fiber optics for microsurgery
Photography; cauterology
Video education classes
Inventory of supplies by computer
Portability of life support systems machinery
Miniaturization of now cumbersome equipment
File/records update during surgery; computer in operating room
Automated cashiering; computerized scales for food portions and pricing
Laser technology: argon laser, CO_2 laser; krypton laser; yag laser; all will affect neurosurgery; endoscopy

6. ARE THERE CERTAIN ATTITUDES THAT YOU FEEL ARE IMPORTANT FOR NEW EMPLOYEES TO BRING INTO THE COMPANY?

Positive/"can do"
Industriousness (2)
Open to change (3)
Independent/initiative (3)
Integrity
Adaptability
Willingness to continue learning (2)
Teamwork/cooperative (3)
Inquiring
Interact with diverse peoples
Maintain composure under stress
Accommodating constructive criticism
Flexible and receptive to innovation (3)
Belief in the basic value of individual human beings
See the potential in others
Genuine caring
Willing to accept training in new field

7. WHAT SKILLS ARE CONSIDERED IN HIRING AND PROMOTIONS?

Crisis skills
Adaptability
Interpersonal skills (3)
Make use of appropriate technology
Management skills (2)
Decision making skills (3)
Leadership (2)
Familiarity with existing technology
Management of human resources
Multiprocedure ability
Sense of humor
Ability to evaluate others
Good judgment

8. WHAT ROLE DO YOU FEEL THAT HIGH SCHOOLS SHOULD PLAY IN HELPING TO PREPARE YOUNG PEOPLE FOR EMPLOYMENT IN A COMPANY LIKE YOURS?

Communications skills: listening (3), written, oral presentations
Interpersonal skills
Cooperative work projects
"World of work" as an area of study (2)
How to prioritize
Expression: written, oral (2)
How to distinguish assertiveness from aggression
How to promote a win-win outcome
Orientation to new technology (4)
Orientation to business component of industry; not just the products/services
Experiential learning: visitations to and experiences at work site (2)

Making informed career choices
Coping skills
Memory skills
Analytical skills (2)
Reading skills: literal and interpretive comprehension (2)
Exposure to other cultures
Role playing

9. WHAT ROLE TO YOU FEEL THAT COMMUNITY COLLEGE/VOCATIONAL PROGRAMS SHOULD PLAY IN TRAINING?

Expand to four-year training program
Interject more practical experience into curriculum
Can't help with hospital administration prep
Focus on the practical side of earning a living, not just education
General orientation to technology
Ensure utilization of communication skills
Blend communications skills and practice
Interpersonal skills

10. WHAT ROLE DOES/SHOULD YOUR OWN COMPANY PLAY IN TRAINING AND UPGRADING EMPLOYEE SKILLS?

Provide tuition reimbursement for additional training
Encourage/support membership in local national organizations
OJT
Network with branches of same company in other cities
Continue management training
Permit training in other departments of interest
Carefully evaluate employees
Orientation to technology (3)

11. DO YOU HAVE ANY OTHER THOUGHTS ON THE EFFECTS THAT TECHNOLOGICAL CHANGE MIGHT HAVE ON PUBLIC EDUCATION?

Information management
Decision making
Determine whether the new technology is expensive for clients
The pace of education
Internship as a means of training teachers for the purpose of seeing the changes that are taking place
Mental discipline
Basis for new research

APPENDIX D: DATA SUMMARY OF EMPLOYER INTERVIEWS-- HIGH TECHNOLOGY

1. JOB TITLES

Assembler II
Director of Human Resources
Technical Writer
Sales Manager
Personnel Manager
Production Training Manager
Computer Engineer

2. WHAT MAJOR TECHNOLOGICAL CHANGES HAVE YOU SEEN IN YOUR COMPANY IN THE PAST FEW YEARS?

Extended addressing capability
Analog to digital display modes
Multiplexing
Computer-aided troubleshooting
Automated testing
Circuit board fabrication
Products: lighter, smaller, more portable, and more versatile
Movement from "Mini-" market to "Micro-" market for sales of specific "systems" software
Movements of "electronic" copy to others for review instead of "hard copy"
Electronic mail
UNIX operating systems
VLSI chip production: new generation of integrated circuits
Assembly: machine insertion
Computer assisted inventory, process control, manufacturing tracking

3. WHAT EFFECTS HAVE THESE CHANGES HAD ON: (A) NUMBER OF NEW EMPLOYEES HIRED, (B) TYPE OF WORK COMPETENCIES NEEDED, (C) TYPE OF FUTURE TRAINING?

3A. Increased sales personnel
Slightly fewer clerical personnel

3B. <u>Professional</u>
Know state-of-the-art technology
Top qualifications in research

<u>General</u>
Good eyesight
Good manual skills
Ability to learn quickly
Accuracy

Reading with comprehension (3)
Attention to detail
Good memory
Good listening skills (2)
Adaptability
Willingness to study after normal work hours
Inquisitive
Need for broad/excellent vocabulary
"Microcomputer" background preferred over "general electronics"

3C. Software and hardware orientation or training
Ability to cope with longer periods of probation on a new job
Training to work in more than one aspect of field
Basic study skills (3)
Various computer systems
State-of-the-art technology
Soldering
Tools applications (manual)
Programming

4. WHAT PARTICULAR OCCUPATIONS OR JOBS WITHIN YOUR COMPANY HAVE BEEN MOST AFFECTED BY TECHNOLOGICAL CHANGES?

Inspectors at assembly plants
Designers
Writers at small companies because of emerging need to know: graphics, book layout, printing where changed by technology
Shipping clerks
Sales: ordering, processing, servicing
Technical writers
Electronic technicians on the way out!
Software technicians in growing demand to modify programs
Won't need as many assembly technicians
Reduction in standard technicians because computers will do more "screen monitoring"

5. WHAT ARE SOME NEW TECHNOLOGICAL CHANGES THAT ARE LIKELY TO IMPACT YOUR FIELD IN THE NEXT FIVE YEARS?

Computer/microprocessor controlled machinery
Mass produced items will be soon produced entirely by computers
Elimination of die casting. Miniaturization means no need for big chassis. Machinery will be lighter and more portable.
Sales will be broken down in specialized departments
Lasers
Continued improvements in current software/hardware
Incremental changes in VLSI chip
Machine inserted parts
Machine manufactured circuit boards

6. ARE THERE CERTAIN ATTITUDES THAT YOU FEEL ARE IMPORTANT FOR NEW EMPLOYEES TO BRING INTO THE COMPANY?

Pride in product
Positive attitude (4)
Open to learning
Open to changes in field, etc.
Invigorated by change potential
Not over-confident
Inquisitive without apologizing
Honesty
Solution oriented rather than "problem" oriented
Tolerance for changes
Care for quality
Solid work ethic (2)
Teamwork (3)
Likes people

7. WHAT SKILLS ARE CONSIDERED IN HIRING AND PROMOTIONS?

Ability to be independent
Accountable
Listening skills
Ability to present ideas orally
Supervisory skills
Technical writing
Flexibility
Analytical
Broader scope of skills preferred over specialized skills (e.g., workers need to know: compensation, policy, employee relations, conflict resolution, etc.)
Good reading skills
Good telephone voice
Technical background
Ability to program in deck commands, Pascal
Interviewing skills
Broad range of writing skills
Ability to concentrate

8. WHAT ROLE DO YOU FEEL THAT HIGH SCHOOLS SHOULD PLAY IN HELPING TO PREPARE YOUNG PEOPLE FOR EMPLOYMENT IN A COMPANY LIKE YOURS?

Classes in computers
Practical electronics
Exposure to expanding jobs in technical fields
Help establish good work habits
Improve science and math course requirements
Align emphasis with changing world economy
Encourage young to take tough courses
Schools should find ways to respond to changing technology
Re-evaluate basic courses; emphasize reading (2)
Increase demand for assimilating information

Destructure courses traditional for boys/girls
Help young accommodate change
Match skills with emerging employment picture
Provide more experiential learning opportunities
Avoid locking into college track options only
Clarify or teach about employers' expectations
Emphasize reading for analysis
Emphasize problem solving and planning skills

9. WHAT ROLE TO YOU FEEL THAT COMMUNITY COLLEGE/VOCATIONAL PROGRAMS SHOULD PLAY IN TRAINING?

Offer four-year engineer program with B.A.
Prepare people to adjust for computer impacted world
Provide good vocational programs to complement four-year programs
Teach more Pascal
More well-equipped teachers for changing times
Improved career counseling
Guarantee basic math skills
Teach logic, speaking skills together for presenting arguments
Provide more internships
Analyze success of company heads
More direct experience in specialized fields

10. WHAT ROLE DOES/SHOULD YOUR OWN COMPANY PLAY IN TRAINING AND UPGRADING EMPLOYEE SKILLS?

Provide inservice
Tuition reimbursement (3)
Internships with company
In-house help with homework
Practical OJT
Company does training at workplace (3)

11. DO YOU HAVE ANY OTHER THOUGHTS ON THE EFFECTS THAT TECHNOLOGICAL CHANGE MIGHT HAVE ON PUBLIC EDUCATION?

Assess the growth of technology
Need improved community college and other educational opportunities for women and minorities
Expand C.C. program to three (3) years
Find ways to bring parents of young more in touch with today's/tomorrow's young people
Use technology creatively